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F-5E FLUTTER MODEL TEST REPORT

PHASE I

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1.0 SUMMARY

This report presents the results of the first phase of wind tunnel tests on the F-5E Flutter Model. The primary objectives of this phase of tests were to establish the flutter characteristics of wing tip store plus clean wing configurations and then examine, in detail, the flutter characteristics of wing tip store plus single wing store configurations. In addition, a secondary objective was to briefly survey double underwing store configurations. Table 2 identifies the configurations tested.

The choice of wind tunnel target speeds was based on the following considerations: First, the maximum tunnel test speed had to be greater than the target flight clearance speeds by a factor of 1.15 to comply with the requirements of MIL-A-8870. Second, previous flight experience with the F-5A had provided evidence to indicate that the compressibility correction factor for certain store configurations might be as high as 1.4 in the Mach Number region from .88 to .92. Third, the tunnel test speeds were to be sufficiently high to provide meaningful data that could be directly used to correlate with analyses.

For the AIM-9B/J missile tip + inboard store configurations, centerline store optional, the test data indicated that these configurations should attain high flutter speed clearances in the order of 560 KEAS or higher. The character of the flutter trends obtained, in view of past experience on other F-5 aircraft, indicated that the missile + launcher wing tip store is correctly located to optimize the clearance speeds of these configurations.

The flutter speeds of launcher + inboard store configurations, centerline store optional, were found to be highly sensitive to which store was mounted inboard as well as which store was mounted on the centerline. For most of these configurations, the flutter speeds were sufficiently high to preclude being a problem; flight clearance speeds of 520 KEAS or higher appeared realistic. However, for a few cases, such as the launcher + inboard BLU-27/B(F) + centerline MK-84 configuration, the clearance speeds may conservatively be as low as 450 KEAS.

The flutter characteristics of the AIM-9B/J and/or launcher plus outboard store configurations, with a clean centerline, were found to be very satisfactory. Only a few flutter points were encountered and these occurred only at very high speeds. Consequently, excellent

1.0 Summary (continued)

flutter clearance speeds in the order of 560 knots or higher are expected for these cases. The centerline store cases were not tested during this phase; they are scheduled for the next phase.

Only a very limited number of tip store plus double wing store configurations were tested. The results, although not conclusive, indicate that these configurations should possess satisfactory flight clearance speeds in the order of 520 KEAS.

The data submitted in the report represents partial fulfillment of the requirements of the basic F-5E contract as well as that of ECP-012R and ECP-013R. The AIM-9E wing tip missile, which was not used in the testing, was considered to be covered by testing the AIM-9B/J missiles.

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3.0 INTRODUCTION

The F-5E is a light-weight supersonic fighter aircraft with the capability of carrying external stores at the wing tips, wing station 123.0, wing station 93.5, and fuselage centerline. Basic and detailed sketches of the airplane are presented in Figures 1 and 2. Although the F-5E is derived from, and similar to, the F-5A/B series of aircraft, substantial modifications were incorporated into the new aircraft.

The primary modifications (pertinent to flutter considerations) were the 8.5 inch extension of the wings to accommodate the wider fuselage, revised wing leading edge extension at the wing root, stiffening of the wings inboard of W.S. 93.5, revised stiffness of the wing carry-through-structure, lengthening and stiffening of the fuselage, increased weight/inertia of the fuselage and inboard wing, and aft shift of the centerline pylon. These changes, together with the obsolescence of the mass and stiffness properties of the previous 0.3 scale F-5A Flutter Model and the limited width of the Northrop low-speed wind tunnel, necessitated the design and fabrication of an entirely new model.

A 0.25 scale full-span free-free Flutter Model (Figures 3 through 9) was designed and fabricated to represent the F-5E aircraft. Based on past experience, and the similarities of the new aircraft to previous aircraft, the emphasis was placed upon dynamically scaling the wings, wing root, pylons, and external stores. In addition, the stiffnesses and mass properties of the fuselage as well as the aerodynamic contour were also simulated. The empennage, which is identical to that of previous aircraft, was represented by planform-shaped flat plates designed to approximately simulate the first resonant frequency of each surface.

The first phase of the test program took place in the Northrop 7'x10' low-speed wind tunnel during the months of July, August, and September 1971. The primary objectives of this phase of tests were to establish the flutter characteristics, including their sensitivity to selected parameter variations, for the following types of configurations:

a) Tip stores + clean wing
b) Tip stores + inboard store
c) Tip stores + outboard store

A follow-on test program, Phase II, was to be utilized to complete the investigation of other remaining configurations.

3.0 INTRODUCTION (continued)

The particular external stores, their respective locations and combinations, used during the tests were selected from the basic F-5E Contractual Stores Matrix identified in Table 1. An attempt was made to arrange the testing so as to be compatible with the anticipated revised Stores Matrices (not shown) associated with ECP 012R and ECP 013R which were currently under negotiation. Advance funding was provided to extend the tests slightly to investigate selected AIM-9B missile tip cases from the revised Stores Matrix. For convenience, Table 2 lists the configurations tested.

The wind tunnel results and all other pertinent data presented in this report have been converted to the equivalent full-scale values, unless noted otherwise. All speeds are quoted as ultimate, in that no factors (for safety, compressibility, etc.) have been applied. Any comparison of the wind tunnel speeds listed in this report with those listed in past reports for the F-5A/B must therefore take into account the 25% factor previously used.

Throughout this report reference is made to the tip store c.g. locations in terms of percent of the wing tip chord. The significance of this notation is the following: The flutter speeds for each external store configuration were established for various c.g. locations of the wing tip store, which were obtained by bodily moving the tip store (i.e., launcher or launcher plus missile as a unit) fore or aft relative to the wing. The tip store c.g. location at each data-point is referred to by specifying its distance aft of the wing leading edge as a percentage of the wing tip chord at Wing Sta. 160. A negative percentage denotes that the c.g. is forward of the extended wing leading edge. The trend curves, in particular, are generally plotted in the form of flutter speed versus tip store c.g. to show what control the tip store has over the flutter characteristics, how sensitive is this control, and what can be expected for the actual airplane installation. The tip store c.g. location can be computed using the data in Table 3 and the formula listed below.

$$\% \text{ chord} = (\text{F.S. of c.g.} - 402.683)(100)/26.931$$

(Note: Ambiguities will occasionally arise between the two forms of wind tunnel data presentation, tables and figures. In these cases, the tabulated data are to be considered correct, since frequently the graphical symbols would have overlapped had they not been misplotted intentionally for clarity. Also, throughout the figures, solid flutter curves denote antisymmetric flutter, dashed curves denote symmetric flutter, and flagged symbols denote no flutter at that point. Frequently in the text and the tables, the tip store + clean wing cases as well as those cases with one or both pylons (only) mounted on the wing are referred to as double store cases. This was done for convenience, only, in preparation of this report.)

4.0 BASIC DATA

4.1 Scale Factors

To provide dynamic similarity, the following scale factors relating model parameters to full scale values were utilized in the design of the model components.

Length:	Full Scale x (1/4)	=	Model Scale
Velocity:	Full Scale x (3/16)	=	Model Scale
Frequency:	Full Scale x (3/4)	=	Model Scale
Weight:	Full Scale x 1/64)	=	Model Scale
Inertia:	Full Scale x (1/1024)	=	Model Scale
Stiffness (EI,GJ):	Full Scale x (9/65536)	=	Model Scale
Air Density:	Full Scale	=	Model Scale

4.2 Design Approach

The design approach used to dynamically simulate the F-5E airplane was to represent the stiffnesses of the wing and fuselage by equivalent single spars appropriately located, and to represent the aerodynamic contour and inertial characteristics by ballasted built-up wood/foam/fiberglass sections attached to these spars. Gaps between these built-up sections were sealed with rubber dental dam to insure aerodynamic continuity. External stores were attached to these spars by means of metal flexures and/or spars designed to give either the equivalent stiffnesses of the full scale pylon or selected resonant frequencies of certain stores. The external stores were represented by ballasted rigidly-constructed, aerodynamically-shaped wood/fiberglass models.

In the design of all components, consideration was given to minimizing the time to change configurations during the tests. Particular care was also exercised in the design and construction to minimize friction. Colors of the various model components were selected to provide good photographic contrast to facilitate identification of major surfaces. The various wing and fuselage sections were numbered to facilitate the recording of vibration data.

4.2 Design Approach (continued)

Figure 3 through 9 present sketches and photographs of the model and suspension system. The following paragraphs give a detailed description of each of the model components.

4.3 Description of Model Components, Design & Measured Data

4.3.1 Fuselage

The fuselage between F.S. 43.4 and F.S. 581.5 was represented by a flexible centerline spar to which rigid, ballasted, independently-mounted, and aerodynamically-contoured sections were attached. The protruding nose boom and tail pipe were not simulated. Ten sections, having quick opening capability, were used as indicated in Figure 9.

The fuselage sections, contoured to conform to the shape of the actual aircraft, were fabricated as mylar-covered wood-fiberglass shells with internal wood or magnesium bulkheads. Each section was clamped to the spar at essentially one point to prevent modifying the spar's stiffnesses. Each section was ballasted to match the design weight, longitudinal c.g. location, vertical c.g. location, and roll inertia.

The fuselage spar was designed to simulate the vertical bending, lateral bending, and torsional stiffnesses of the fuselage. The spar was a one-piece construction consisting of two straight segments: Aft of fuselage station 220, the spar centerline coincided with waterline station 102.72; while forward of fuselage station 220, the spar centerline was sloped down an angle of 4.10° to keep it within the fuselage mold line. The spar terminated at F.S. 72.0 and at F.S. 552.0. The slope at the forward end of the spar was considered negligible and ignored during the design computations of the required cross-sections of the spar. The design stiffnesses of the fuselage spar are presented in Figures 10A and 10B.

The engine inlets were extended forward and conically faired into the fuselage mold line. These fairing extensions were removable to permit future studies, if time permits, on how the wing flutter characteristics are influenced by the airflow patterns coming off the inlet fairings. The assembled fuselage was marked with

4.3.1 Fuselage (continued)

reference lines to identify the horizontal reference plane (W.L.100) and the vertical mid-plane.

The mass/inertia data for the fuselage are listed in Tables 4A and 4B. The first table lists design data for the empty and full fuel conditions, along with empennage and ammo data. The model was ballasted to be representative of the full fuel condition, including ammo. The latter table lists the measured data.

In regard to the ballasting of the fuselage, Tables 4A and 4B, note that the empennage and fuselage were ballasted as combined components. Also, to improve the model's rigid body dynamic stability characteristics, it was necessary to add additional ballast in the forward end of the fuselage to shift the model's c.g. forward. For runs 76 through 82, ten pounds (model scale) were added at F. S. 217.16. For runs 83 and on (but excluding runs 409 and 410 with the weights temporarily removed), the additional ballast was changed to twenty pounds at F.S. 213.16. These additional ballast weights were located near the fuselage node lines in the fundamental bending modes to minimize their influence on test data.

4.3.2 Empennage

Because of the similarity of the empennage of the F-5E and F-5A airplanes, detailed simulations of these surfaces were not necessary. Simple representations of planform-shaped flat magnesium plates were used for the vertical fin and horizontal tail. The thickness and tapers of these plates were selected to give the proper fundamental bending frequencies of the surfaces and to keep the weight within reasonable limits. The vertical fin and fuselage section 9 were ballasted as a unit to match the design parameters. Similarly, the horizontal tail and fuselage section 10 were ballasted as a unit.

The mass/inertia data for the empennage plus fuselage are listed in Tables 4A and 4B. The resonant frequencies of the fundamental modes are identified below.

4.3.2 Empennage (continued)

	Design	Measured
Vertical fin		
First bending	17.6 Hz	15.6 Hz
First torsion	52.0 Hz	46.9 Hz
Horizontal tail		
First bending	21.7 Hz	23.1 Hz
First torsion	46.7 Hz	87.7 Hz

4.3.3 Wing

The wing was represented by a single flexible spar to which were attached ten rigid, ballasted, independently-mounted streamwise sections. The aileron was designed as a separate component and flexibly mated to the wing, while the leading and trailing edge flaps were considered integral parts of the wing. A sketch of the wing sections is shown in Figure 8.

The ten wing sections were wood-fiberglas mylar-covered constructions with wood or magnesium ribs. Each section was clamped to the wing at a single spanwise station to avoid changing the effective wing spar stiffnesses. Each section (with the spar weight/inertia taken into account) was ballasted to simulate the full scale weight, fore and aft c.g. location, and pitch inertia. For simplicity, the inboard wing section was broken up into two parts (as indicated in Figure 8), one of which attached to the wing spar and the other of which mated rigidly to the fuselage, to account for the different mold lines of the fuselage above and below the wing. The total mass/inertial properties of wing section one were placed into the outboard or moveable part.

The wing spar was a straight one-piece aluminum construction designed to simulate the torsional and vertical bending stiffnesses of the wing between W.S. 30.0 and W.S. 151.0. Except in the area of the inboard pylon (W.S. 74 to W.S. 93), where it was approximately four times stiffer, this spar also simulated the fore and aft stiffness of the wing. The straight axis of the spar was aligned by a Least Square fit to the full-scale wing's elastic axis. The tip of the spar terminated in a rib containing a lug forward and a pin-joint aft and inboard of the lug, to be representative of the geometrical mounting arrangement for wing tip stores that exists on the full scale structure. The stiffnesses

4.3.3 Wing (continued)

of the lug and tip rib were not scaled but, instead, were made as rigid as possible so that all the wing torsional stiffness in this region was simulated by an equivalent twist of the launcher rail along its fore and aft axis. The root of the wing spar clamped to the carry-through plate.

In the design of the wing spar, one further point should be noted. The design stiffnesses, and shear centers, of the full scale wing were computed by taking cross sections perpendicular to the wing's 35% chord. The dimensions of the model's wing spar were computed from this data, ignoring the small difference in the sweep back angles of the spar axis and the 35% chord.

The assembled wing was marked with reference lines to identify the 15%, 35%, and 66% wing chords and a reference line to identify the axis of the spar. The design and measured properties of the wing are tabulated in Tables 5A and 5B and Figure 11.

4.3.4 Aileron

The aileron was fabricated as a mylar-covered balsawood framework of ribs joined together at the hinge line and at the trailing edge by wood spars. The aileron was hinged to the magnesium center ribs of wing sections 5 and 7 by using Bendix Flexural Pivots # 6006-600: The pivots represented frictionless zero-spring-rate hinges. Two such pivots were used for each aileron to provide freedom in rotation about the hinge line. Two additional pivot pins oriented perpendicular to the hingeline and located at the same location as the Bendix pivots, as well as a sliding joint at section 7, were used to prevent tying sections 5 and 7 together which would have changed the effective stiffnesses of the wing spar in this vicinity.

The assembled aileron, minus the hingeline bracketry, was ballasted to the design weight, spanwise and chordwise c.g. locations, and streamwise pitch inertia. The mass/inertia data are presented in Table 5. The hingeline bracketry was included as part of wing sections 5 and 7.

4.3.4 Aileron (continued)

The required rotational frequency of the aileron was achieved by the use of a torsional flexure, coincident with the hingeline and with an extremely low vertical bending stiffness, connecting the aileron to the magnesium center rib of wing section 4. Several flexures were fabricated to permit parameter studies during the wind tunnel tests. The design frequencies of the flexures are listed below.

Flexure # 1	frequency = 40.0 Hz (nominal)
Flexure # 2	frequency = 48.0 Hz
Flexure # 3	frequency = 32.0 Hz
Flexure # 4	frequency = Rigid

4.3.5 Wing Carry-Through Structure

The right and left wing spars attached at their roots to a flat aluminum carry-through plate which simulated the average vertical bending stiffness of the airplane's carry-through bay. The wing spars plus carry-through plate were suspended from two fuselage bulkheads by the use of two Bendix flexures (#6024-600) per side. As in the aileron design, these flexures represented frictionless zero-spring-rate hinges, with the axes of the hinges parallel to the fuselage centerline. The arrangement was such that all roll moments were transmitted directly to the carry-through plate, while all pitch moments and vertical shear was transmitted to the fuselage beam.

As indicated below, the trunion points on the model where the wing mated to the fuselage were representative of those on the airplane. A slight difference existed between the width of the model's carry-through bay and that of the airplane due to interference with the model fuselage. This was accounted for by changing the design stiffness of the model carry-through plate slightly so that the slope at the root, due to the static roll moment of the wing, were the same on the model as on the airplane. In addition, the model spar between Wing Sta. 30, the location of the wing root, and wing station 26.6 was designed to be effectively rigid.

4.3.5 Wing Carry-Through Structure (continued)

	Airplane		Model	
Trunion	Fus. Sta.	Wing Sta.	Fus. Sta.	Wing Sta.
Forward	336.37	33.72	343.40	26.60
Aft	374.25	27.80	374.92	26.60

The end result was that the carry-through-plate was designed to the following stiffness

$$EI = 1442.3 \times 10^6 \text{ lb-in}^2$$

(equivalent to 0.95642 times the average aircraft carry-through bay EI value of 1508×10^6)

4.3.6 Pylons

The centerline pylon consisted of a rigid ballasted fairing with an internal flexure. The fairing plus flexure was ballasted to the design weight and fore and aft c.g. location. Several flexures were fabricated to permit variation of the centerline store resonances. The flexures fabricated are identified in Table 10.

The W.S. 93.5 pylon was represented similarly: rigid ballasted fairing with an internal flexure. Again several flexures were fabricated, as indicated in Table 10. For this pylon, however, the axis of the flexure was swept forward to coincide with the pylon's elastic axis. The fairing plus flexure was ballasted to the design weight and to the design fore and aft unbalance and inertia about the wing spar.

The W.S. 123 pylon consisted of three components: fairing, spar, and a flexure. The total assembly was ballasted in a manner similar to that of the inboard pylon. The pylon's spar was a one-piece aluminum beam composed of several

4.3.6 Pylons (continued)

straight segments, oriented so as to coincide with the pylon's elastic axis. The spar simulated the lateral, vertical, and torsional stiffness of the full-scale structure. The flexures, used to join the store to the pylon spar, were designed to be representative of the bomb rack's sway brace flexibility in pitch and roll. The design stiffnesses of the pylon spar are presented in Table 9. The resonance frequencies of the cantilevered pylon spar + flexure with a store installed are tabulated in Table 10.

Both wing pylons (fairing + spar and/or flexure) were capable of being shifted fore or aft relative to the wing, for the purpose of conducting parameter studies. All pylon to store attachments were such that any store could be installed on any of the pylons. Mass data for all the pylons are tabulated in Table 6.

4.3.7 Wing Tip Stores

Three wing tip stores were constructed: Launcher, AIM-9J and AIM-9B. The missiles were rigid replica of the full-scale AIM-9 that were ballasted (as was the launcher) to the design weight, fore and aft c.g. location and pitch inertia. The launcher was a wood-aluminum construction designed to be representative of the torsional stiffness of the full scale structure between the wing mounting lugs. The launcher, with or without the missile installed, was capable of being shifted fore or aft relative to the wing.

The design mass/inertia properties for the launcher and missiles are tabulated in Table 7A, while the measured properties are listed in Table 7B. Note:. At the end of the test program, revised design data were obtained for the missiles, but the data were received too late to be utilized in the tests. The wing tip missiles will be updated for the next phase of wind tunnel tests.

4.3.8 External Pylon Stores

Three types of rigid pylon stores were constructed: a fiberglas 275 gallon tank, wooden or fiberglas replicas of full-scale stores, and variable-mass fiberglas/wooden stores. All of the stores were ballasted to weight, fore and aft (and, approximately, vertical) c.g. location, and

4.3.8 External Pylon Stores (continued)

pitch inertia. The following list identifies the stores, including tip stores, that were fabricated.

Amount	
1	MK-84
1	275 gallon tank
2	Launchers
2	AIM-9J
2	AIM-9B
4	Empty LAU-3/A
2	MK-82; convertible to MK-82S/E
2	BLU-32/B(F); with detachable fins
2	BLU-27/B(F); with detachable fins
4	Variable mass; 17.0" dia., 116.0" length
4	Variable mass; 10.0" dia., 64.0" length, with extensions to achieve a 96.0" length

The centerline 275 gallon tank was a nine compartment translucent shell capable of carrying a liquid,Mobil Velocite Oil # 3, to simulate the fuel. The compartmentization permitted testing nose-up and nose-down, as well as level, airplane attitudes.

Several of the replicas of the full-scale stores were designed to simulate the different versions of the full-scale items. For example, the BLU-27/B's and BLU-32/B's were fabricated with removable tail fins to be representative of the finned or unfinned stores. The MK-82 (standard) was convertable to a MK-82 S/E. For the empty LAU-3/A simulation, hollow ballasted fiberglas shells were used.

The variable-mass stores were finless, aerodynamically contoured, hollow tubes with detachable nose and tail cones and removeable lead-foam inserts. The mass properties were to be varied by changing the lead-foam inserts. If necessary, as was the case for the smaller diameter variable-mass stores, the length was also variable by adding extensions. The purpose of the variable-mass stores was to provide the capability of performing parameter studies and to permit coverage of the other stores in the Contractual Stores Matrix which were not duplicated.

4.3.8 External Pylon Stores (continued)

The design and measured mass/inertia data for all the stores, other than the variable mass stores, are tabulated in Table 7A and 7B. In preparation of the model stores, it was noted that the BLU-32/B(F)'s listed inertia of 99.0 slug-ft^2 was inconsistent with available BLU-32/B(U) data and the published weight/c.g. of the fins. The model BLU-32/B(F) stores were accordingly ballasted to what was considered to be a more representative inertia, 112 slug-ft^2. Data received at the end of the test program, Table 7A, confirmed the adequacy of this design value.

The variable-mass store properties are presented in Table 8. Very few of the configurations listed were tested during this phase due to lack of time.

4.3.9 Suspension System

The F-5E model suspension system was a modification of the torsion bar system used on the previous F-5A Flutter Model. This time, however, there were no bottom springs. A sketch of the system is shown in Figure 7.

Each of the four upper springs consisted of a 1/2 inch thick, hexagon cross section, 'torsion' bar fifteen to seventeen feet long that was clamped at one end and connected to a circular, 14 inch radius, disk at the other end. The disk served to convert the torsional spring into a linear spring. The spring rates and location of the spring-to-model attach points are identified below. A "Whiffle-Tree" type drag harness was used to hold the model longitudinally.

4.3.9 Suspension System (continued)

Spring	Spring Rate lb/in	Attach Point Fus. Sta. inches	Span Sta. inches	Waterline inches
Fwd. Pitch	2.076*	241.736	0	102.72
L.H. Roll	2.004*	360.0	-32.0	133.12
R.H. Roll	2.004*	360.0	+32.0	133.12
Aft Pitch	2.242*	442.840	0	102.72

*Model Scale Units

The model, after each configuration change, could be leveled and centered in the wind tunnel by proportionally rotating the clamped ends of the four torsions bars. Usually, however, the clamped ends were rotated on a non-proportional basis so as, not only to level and center the model, but also to minimize the loads in all the torsion bars.

The model was trimmed during runs by a combination of two techniques. Prior to the run, the horizontal tail was trimmed nose down with shims (usually 1.0°, 1.5°, or 2°) to make the zero angle-of-attack attitude of the model be approximately the necessary attitude for zero aerodynamic moment. Fine tuning of the attitude and height during a run was then accomplished by appropriately rotating the clamped ends of the pitch springs. The preliminary trimming prior to the run had the dual advantage of minimizing the airloads, which the springs had to carry, and minimizing the amplitude of the transient motion of the model during rapid shut downs.

The rigid-body motions were controlled by 'twang' wires attached to the model components. In addition, the model's rigid-body vertical and lateral motion were limited by safety cables which stopped the model if it exceeded the pre-set limits of ± 4.0" vertically and ±12.0" laterally. This system had the advantage of adding no restraints to the suspension system and model during test runs, in that with the model centered in the tunnel these cables were all slack.

5.0 INSTRUMENTATION AND TEST PROCEDURES

5.1 Instrumentation

The instrumentation for the model, during test runs, basically consisted of strain gages and instantaneous oscillograph read-outs. Except for the fuselage and centerline pylon gages, matching strain gages were installed on the left and right sides of the model. The following strain gages were used:

a) Wing spar, W.S. 46.80: bending and torsion gages
b) Wing spar, W.S. 54.00: (spare) bending and torsion gages
c) Wing spar, W.S. 130.8: bending and torsion gages
d) Fuselage spar, F.S. 236.0: Vertical and lateral bending gages
e) Fuselage spar, F.S. 454.0: Vertical bending, lateral bending, and torsion (roll) gages
f) W.S. 123.0 pylon spar: bending and torsion gages
g) W.S. 93.5 pylon flexure: bending and torsion gages
h) Fuselage ℄ flexure: bending and torsion gages
i) Suspension system torsion bars: torsion gages

Several photographic components were used to visually record the model's response during test runs. Two high speed movie cameras, one mounted to the side of the model, and one mounted downstream of the model, were used periodically to record the model's response at selected flutter test points. A closed circuit TV camera - recorder system was used as a backup to continually monitor the test runs. The TV tapes were not saved, though, unless of special interest.

Vibration of the model was accomplished by using specially fabricated light-weight shakers, vibration probes, frequency generators, and the above strain gages along with other pertinent equipment for monitoring the amplitudes, phases and waveforms of the signals. Transits and timers were used for the calibration and ballasting of the various model components.

5.2 Test Procedures

The procedure used in the vibration tests of the model was to first identify the resonances by performing frequency sweeps, while monitoring the various strain gages. The resonances were then 'tuned-in', the mode identified, and (if significant wing motion existed) the wing node line recorded. Amplitude surveys of the model's mode shape were not performed.

5.2 Test Procedures (continued)

The wind tunnel test procedure was to first align the model in the center of the tunnel and then increase the airspeed, in small increments, until flutter or the target maximum speed was reached. During this process, the model was manually excited periodically with transient impulses by means of 'twang' wires attached to the various model components. The decay rate of the strain gage signals were monitored to establish the flutter point. Control of the model by use of the 'twang' wires and rapid reduction of speed were sufficient to prevent damage to the model when flutter was encountered.

6.0 DISCUSSION OF RESULTS

Reiterating, the results presented and discussed below have all been converted to the equivalent full-scale values, unless noted otherwise. In particular, the speeds are quoted as ultimate in that no factors (for safety, compressibility, etc.) have been applied.

The wind tunnel tests results are tabulated in Tables 12 through 17. Selected portions of these data are plotted in Figures 12 through 34. The vibration results are tabulated in Table 11. Table 2 summarizes the configurations tested. All wind tunnel testing, during this phase of testing, were accomplished using the following flexures:

Aileron	Flexure # 1
W.S. 123 pylon	Flexure # 1
W.S. 93.5 pylon	Flexure # 1
℄ pylon	As noted in the tables

All pylons were located in the nominal fore-aft position.

6.1 Rigid Body Cases

The wind tunnel tests were initiated with the suspension system as described in Section 4.3.9 except that the roll springs were located at F.S. 374.92. The model was configured with launchers plus clean wing and centerline. During the third run, the model incurred minor damage due to a rigid body instability at 837 knots (157 knots, model scale). A review of the video records and available rigid body aerodynamic data indicated that a marginally damped dynamic stability condition at 837 knots gave rise to excessive amplitude in the pitch-plunge mode and that, during the nose down portion of the oscillation, the model became statically unstable due to non-linearity of the aerodynamic pitching moment.

For subsequent runs, the model + suspension system was revised as follows: The effective elastic center of the suspension system was shifted forward, by moving the roll cables from F.S. 374.92 to F.S. 360.0, and the safety cables were re-adjusted to limit the model angle-of-attack excursions to $-9.1^\circ \leq \alpha \leq 13.7^\circ$, along with increasing their diameter to 1/8 inch. These changes eliminated the possibility of static divergence. To improve the dynamic stability characteristics, the model's c.g. was shifted forward by the addition of a 10.0 lb. (model scale) ballast weight at F.S. 217.16. The weight was located near the fuselage's first bending modes to minimize influencing the flutter results.

6.1 Rigid Body Cases (continued)

During the subsequent runs, the model's dynamic response was found to be unsatisfactory. Excessively large amplitudes and low rigid body damping caused a considerable increase in run time, as well as creating a significant risk of model damage. Consequently, dampers were added to the forward and aft pitch cables for run 21 and on. For run 83 and on, but excluding check runs 409 and 410, a further modification was made by increasing the fuselage ballast from 10.0 to 20.0 lbs. (model scale).

The above changes in the model + suspension system were found to be sufficient for the tip store + single wing store + optional ℄ store cases. Periodic repeats of test runs, noted in Tables 12 through 17, showed that these modifications did not significantly alter the flutter test data.

For the double wing store cases, the above changes were found to be inadequate. The AIM-9J + double BLU-27/B(F) + clean ℄ cases exhibited dynamic rigid body divergence at 552 knots (138 knots, model scale). All subsequent tests of double wing store cases were then arbitrarily kept below this speed. Re-examination and updating of the rigid body stability equations were scheduled as part of the design effort prior to the Phase II tunnel tests, with the object of modifying the model + suspension system to permit testing to higher speeds.

6.2 Vibration Results

Table II summarizes the resonances noted during the vibration tests of the various flutter model store configurations. Brief descriptions of the resonances are given. For most of the resonances listed, the wing node lines have been measured and will be presented in the Phase II report.

6.3 Tip Store + Clean Wing Cases

Configurations with launchers or missile + launchers on the wing tips, no wing pylons, and either no pylon or a MK-84 on the centerline exhibited excellent flutter stability. As indicated by Table 12 and Figure 12, no flutter was encountered below 880 knots if the wing tip store's c.g. was properly located forward of the wing's leading edge, as is the case on the actual airplane.

6.3 Tip Store + Clean Wing Cases (continued)

The few flutter points obtained were characterized as follows: For tip store c.g.'s aft of the wing's leading edge, the missile tip cases would flutter symmetrically (if the ℄ was clean) or antisymmetrically (if the ℄ was loaded) in the fundamental wing bending and torsion modes. For tip store c.g.'s very far forward of the wing's leading edge, the missile tip cases would flutter symmetrically (but at very high speeds) due to coupling of wing modes and fuselage modes.

6.4 Launcher + Inboard Store Cases

These launcher cases proved to be interesting in two main respects: For the clean centerline cases, a configuration with a light weight/inertia store inboard proved to be more critical than that with a heavy store inboard, whereas it originally was thought to be just the opposite. For the centerline store cases, the flutter speeds were found to be very sensitive to the particular combination of inboard store and centerline store being tested. As discussed below, the key item appeared to be that the flutter instabilities were due to the proximity, and coupling, of wing and fuselage modes.

The numerous tests indicated, as a general overall trend, that only a few of these launcher + inboard store + optional centerline store cases had flutter speeds low enough to be of concern. Moreover, even in the cases of concern, the flutter speeds were on the borderline of being acceptable operationally for flight. It was also readily apparent that the task of establishing the minimum flutter speeds of the various launcher + inboard store + optional centerline store cases was quite formidable in that it was particularly time consuming to examine almost each and every combination of inboard and centerline store, as well as model the centerline pylon with exceptional accuracy. Also, the fact that one of the coupling modes was that of the fuselage, which was not inertially scaled to close tolerances, lead to some uncertainty as to the accuracy of the wind tunnel flutter speeds for these flutter instabilities.

6.4 Launcher + Inboard Store Cases (continued)

The flutter characteristics of the launcher + inboard store configurations, with a clean centerline, are tabulated in Table 13 and plotted in Figure 13. The plotted data reveals several significant facts: First, all of these cases should have operationally acceptable flutter clearances. Second, the light weight/inertia inboard store case proved to be the more critical. Third, the flutter characteristics (speed, frequency, and mode) were quite sensitive to what was mounted on the W.S. 93.5 pylon.

In regard to the type of flutter (c.g., Figure 13), the BLU-27/B(F) inboard store case exhibited flutter in high order wing modes. All the other launcher + inboard store cases exhibited flutter due to coupling of low order wing and fuselage modes. For the MK-82 case, in particular, a very strong torsional motion of the aft fuselage and empennage as well as a pronounced lateral bending of the forward fuselage was obvious during the flutter mode. Also, for the MK-82 case, the flutter mode visually appeared to be the same for forward, as well as aft, launcher c.g. locations but the flutter frequency was distinctly different as indicated in the figure.

Figure 14 and Tables 13B-13E present data showing that the launcher + inboard store flutter characteristics vary significantly due to the installation of a centerline store. Figures 15 and 16 illustrate the variation in flutter speeds caused by changing the inboard store, while holding the centerline store fixed. Several observations are apparent from these figures:

a) The flutter speeds of these cases are governed by the inboard store as well as the store on the centerline. That is, to each specific inboard store, there corresponds one specific centerline store (i.e. critical combination) which gives rise to the lowest flutter speeds.

b) The most critical combination observed is the BLU-27/B(F) inboard + centerline MK-84 case, with flutter speeds of the order of 520 to 660 knots depending on the launcher c.g. location. All other critical combinations, such as a MK-82 inboard + 50% full centerline 275 gallon tank, had higher flutter speeds, 670 knots or above. It appears that, the heavier the inboard store is, the lower will be the flutter speeds of the critical combination.

6.4 Launcher + Inboard Store Cases (continued)

c) For the BLU-27/B (U or F) + MK-84 case, an in-flight clearance speed of the order of 450 to 560 knots is anticipated based upon wind tunnel flutter speeds and the probable subcritical decay rate. The 450 knots clearance is actually more realistic since past experience with the previous F-5A flutter model has indicated that the flutter characteristics for the model tip store c.g. location of approximately -30% to -40% may correlate best with that of the airplane. For other inboard store cases, minimum flight clearance speeds of 520 knots are expected.

Some parameter variation studies were performed to further investigate the flutter characteristics of the launcher + inboard store + centerline store configurations. The first of these consisted of varying the centerline store's resonances. These results, Figures 17-19 and Tables 13B-13E, showed that the roll frequency of the centerline store was the most important and that some 'tuning' of the flutter speeds could be achieved by stiffening the centerline pylon. This type of 'fix' does not appear to be particularly promising, though, since it seems that the end result would be to substitute one critical combination (inboard + centerline store) for another, both of which have about the same minimum flutter speeds. In view of the fact that centerline store's yaw mode does not significantly affect the flutter characteristics, it tentatively appears that an alternate fix might be to change the character of the centerline store mode shapes so that roll and yaw are highly coupled, and pure roll no longer exists.

One additional parameter study, that of adding ballast to the launcher, was also performed. The results, in Figure 20 and Table 13E, show that such a fix will work but considerable ballast (32 to 48 lbs) must be used. The most effective way to use the ballast is to put it as far forward on the launcher as possible.

6.5 Launcher + Outboard Store Cases

The test results for the launcher + outboard store cases, with a clean centerline, are presented in Figure 21 and Tables 14A and 14B. The basic characteristic that may be associated with these configurations was that they were exceptionally stable, as indicated in the figure. Nearly all the cases were tested to speeds over 800 knots without encountering flutter. Two cases, with the empty pylon or empty LAU-3/A outboard, did exhibit flutter but only for aft launcher positions and at speeds above 730 knots. Consequently, in view of these results, no problem area is anticipated in obtaining adequate inflight clearance.

6.5 Launcher + Outboard Store Cases (continued)

No tests were performed during this wind tunnel phase on launcher + outboard store + centerline store cases. Such configurations are to be tested in the next phase.

6.6 Launcher + Double Wing Stores Cases

These cases are primarily scheduled for the next phase of wind tunnel tests. However, a few such configurations were examined briefly here. The results are tabulated in Table 14B.

Most of the tests involved only spot-checks to determine how the flutter characteristics of clean wing or single wing store cases changed when wing pylons were added. The results showed that the addition of the outboard, the inboard, or both wing pylons did not significantly change the flutter characteristics established for the basic cases, single wing store or clean wing.

Only one actual launcher + double store case was tested: MK-82's inboard and outboard. The results indicated excellent stability characteristics up to and including 720 knots.

6.7 Missile Tip + Inboard Store Cases

The first series of tests investigated the AIM-9J cases with a clean centerline. The results exemplified by Figure 22, showed that these configurations had three general basic types of flutter trends, all of which are strongly dependent upon the tip store c.g. location:

a) Symmetric flutter in the fundamental wing modes for tip store c.g. locations aft of the wing 20% chord.

b) Antisymmetric flutter in the fundamental wing modes for tip store c.g. locations in the vicinity of the wing leading edge. Of special interest was the fact that the antisymmetric flutter asymptotes were aft of the -30% chord location in all cases.

c) Symmetric flutter in the higher wing-fuselage modes for tip store c.g. locations far forward of the wing leading edge.

6.7 Missile Tip + Inboard Store Cases (continued)

Past experience on the F-5A/B aircraft had indicated that the model's flutter characteristics, at a tip store c.g. location of -30% to -40% of the wing tip chord, correlate best with that of the actual airplane. In view of this and Figure 22, it is important to note that the c.g. of the F-5E's AIM-9J+ launcher is at a location on the aircraft which should permit high clearance speeds for all the AIM-9J + inboard store + clean centerline configurations.

The key features noted about the AIM-9J + inboard store + centerline store configurations were that they possessed essentially similar flutter trends as the clean centerline cases and that the antisymmetric flutter asymptotes were aft of the -30% chord location. This was verified using three inboard stores (the BLU-27/B(F), BLU-32/B(F), and MK-82) and a variety of centerline stores. The results are presented in Figures 23 through 26 and in Tables 15C through 15F. Additional tests, Figures 27 through 30, showed that the antisymmetric flutter asymptote locations for these configurations were not adversely affected (i.e., shifted forward of the -30% chord location) by variations of the centerline store's resonances.

Three representative AIM-9B + inboard + centerline store cases were tested, Table 15F and Figure 31. The figure, in particular, shows that the AIM-9B cases tend to have higher flutter speeds and slightly more forward antisymmetric flutter asymptotes than the corresponding AIM-9J cases.

Figure 32 and Table 15F present data showing how the flutter trends of a typical missile tip + inboard store + centerline store configuration varied when ballast was added to the wing tip launcher. This data is presented for reference purposes only in support of the parameter studies of ballasting the launcher, which were discussed at the end of Section 6.4.

6.8 Missile Tip + Outboard Store Cases

The test results showed that the missile tip + outboard store configurations, with a clean centerline, were characterized by high speed flutter of the fundamental wing-fuselage modes. The flutter speeds were generally in the vicinity of 780 to 880 knots for mid-range tip store c.g. locations. The results are presented in Figure 33 and Tables 16A-16B. Configurations with centerline stores were not examined during this phase of tests.

6.9 Missile Tip + Double Store Cases

Only a few of these double store configurations were tested during this phase of the wind tunnel tests. The results are tabulated in Tables 17A and 17B and plotted in Figure 34.

The first series of tests were performed to verify that the addition of one or both wing pylons to the missile tip + clean wing, missile tip + inboard store, or missile tip + outboard store configurations did not significantly alter the flutter trends previously established. The tabulated data indicates that this was indeed the case.

Two double wing store cases, double MK-82's or BLU-27/B(F)'s were briefly tested. The results (figure 34) indicated that, for 'light' wing stores, these configurations were characterized by high speed flutter: 640 to 720 knots if the AIM-9B's were on the wing tip, and above 690 knots if the AIM-9J's were used. The 'heavy' double store case appeared to be highly stable.

TABLE 1
F-5E STORES MATRIX
(BASIC CONTRACT)

WING TIPS	INBOARD → OUTBOARD ↓	CLEAN	PYLON	BLU-27/B(U)	BLU-27/B(F)	MK-82	MK-82S/E	M117D	M129	BLU-32/B(U)	BLU-32/B(F)	CBU-24B/B	CBU-49B/B	LAU3/A, 3A/A	CENTERLINE
AIM-9J MISSILE AND/OR LAUNCHER RAILS	CLEAN	X	X	X	X	X	X	X	X	X	X	X	X	X	ANY OF THE FOLLOWING: CLEAN PYLON 275-GAL TANK BLU-27/B(U) BLU-27/B(F) MK-82 MK-82S/E M-129 BLU-32/B(U) BLU-32/B(F) CBU-24B/B CBU-49B/B MK-84 SUU-20A/A
	PYLON	X	X	X	X	X	X	X	X	X	X	X	X	X	
	BLU-27/B(U)	X	X	X											
	BLU-27/B(F)	X	X		X										
	MK-82	X	X			X									
	MK-82S/E	X	X				X								
	M129	X	X						X						
	BLU-32/B(U)	X	X							X					
	BLU-32/B(F)	X	X								X				
	CBU-24B/B	X	X									X			
	CBU-49B/B	X	X										X		
	LAU-3/A,3A/A	X	X											X	
	SUU-25A/A	X	X												
	TDU-10/B	X													RMU-10/A REEL
TDU-11/B (LH ONLY) AND AIM-9J MISSILE	CLEAN	X													CLEAN

NORTHROP ____________ Aircraft Division

Figure 1
F-5E Three-View Drawing
Page 30
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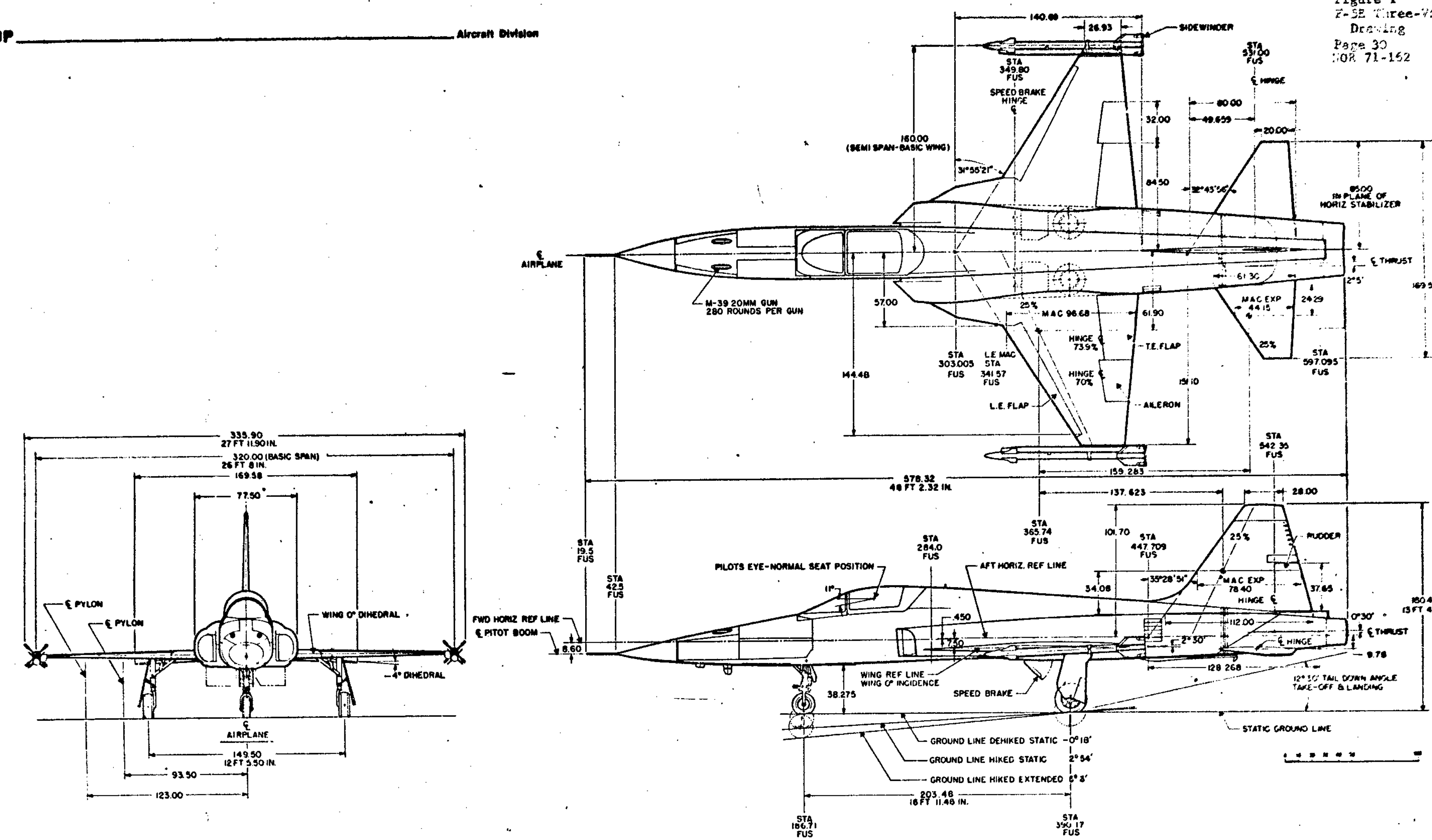
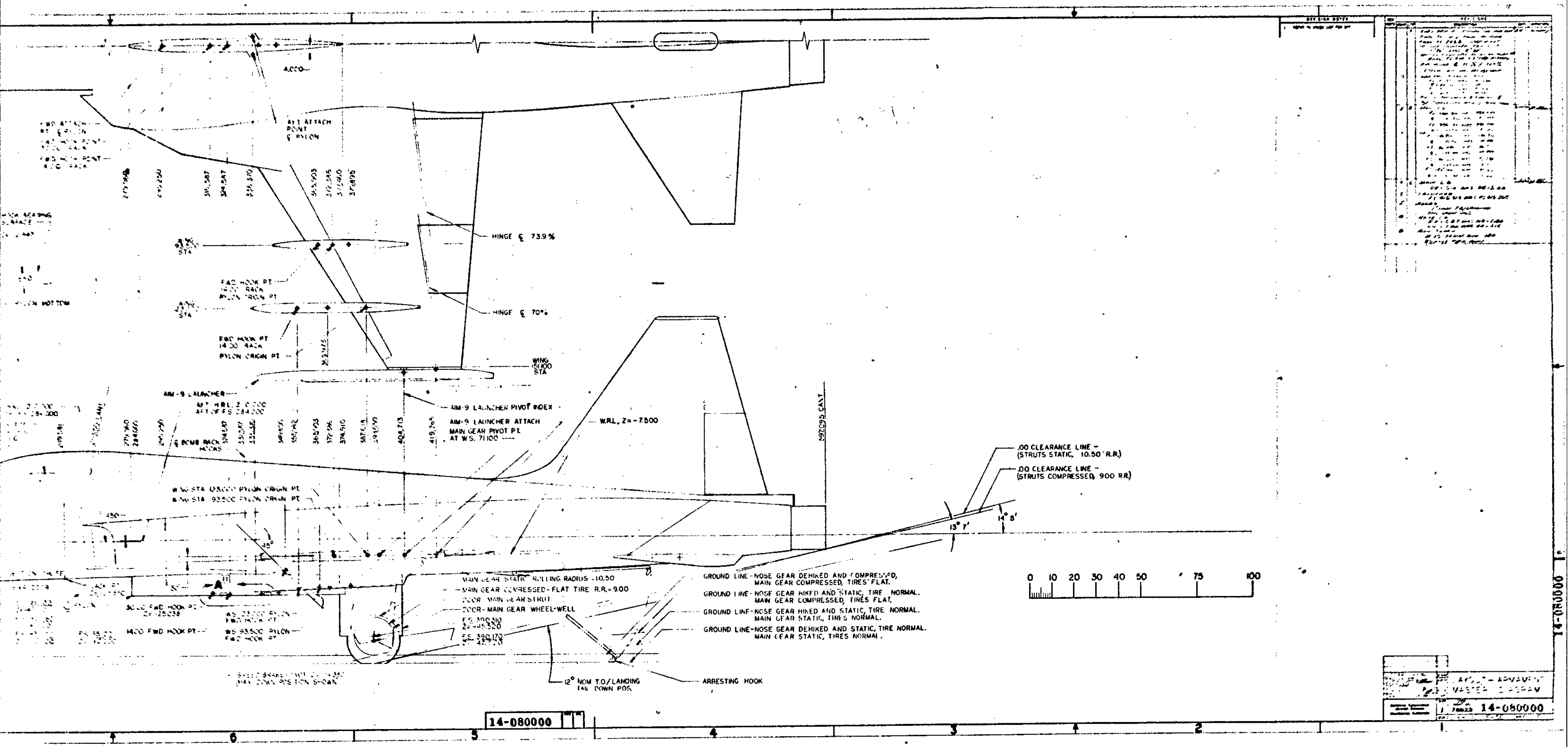
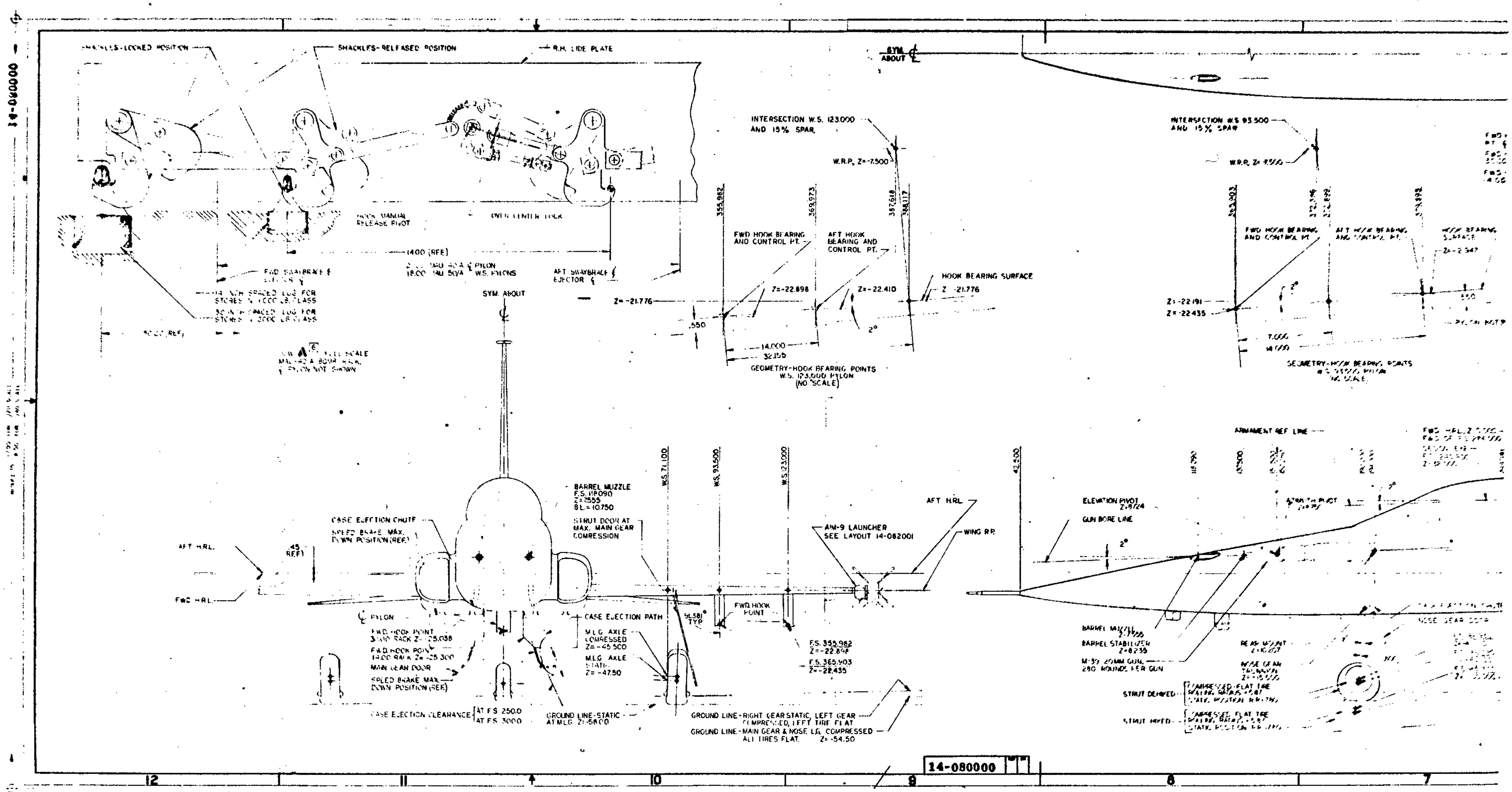



HINGE ℄ 73.9%
HINGE ℄ 70%
WING 151.00 STA
AFT ATTACH POINT ℄ PYLON
4.000
FWD HOOK PT 14.00 RACK PYLON ORIGIN PT
AIM-9 LAUNCHER
AIM-9 LAUNCHER PIVOT INDEX
AIM-9 LAUNCHER ATTACH
MAIN GEAR PIVOT PT AT W.S. 71.100
W.R.L. Z=-7.500
597.095 CANT
404.713
419.265
.00 CLEARANCE LINE - (STRUTS STATIC, 10.50 R.R.)
.00 CLEARANCE LINE - (STRUTS COMPRESSED, 9.00 R.R.)
13° 7'
14° 8'
0 10 20 30 40 50 75 100
GROUND LINE - NOSE GEAR DEHIKED AND COMPRESSED, MAIN GEAR COMPRESSED, TIRES FLAT.
GROUND LINE - NOSE GEAR HIKED AND STATIC, TIRE NORMAL. MAIN GEAR COMPRESSED, TIRES FLAT.
GROUND LINE - NOSE GEAR HIKED AND STATIC, TIRE NORMAL. MAIN GEAR STATIC, TIRES NORMAL.
GROUND LINE - NOSE GEAR DEHIKED AND STATIC, TIRE NORMAL. MAIN GEAR STATIC, TIRES NORMAL.
MAIN GEAR STATIC ROLLING RADIUS -10.50
MAIN GEAR COMPRESSED-FLAT TIRE R.R.=9.00
MAIN GEAR STRUT
DOOR - MAIN GEAR WHEEL-WELL
12° NOM T.O./LANDING TAIL DOWN POS.
ARRESTING HOOK
14-080000



SHACKLES-LOCKED POSITION
SHACKLES-RELEASED POSITION
R.H. SIDE PLATE
HOOK MANUAL RELEASE PIVOT
OVER CENTER LOCK
1400 (REF)
FWD SWAYBRACE ℄
AFT SWAYBRACE ℄ EJECTOR ℄
SYM. ABOUT ℄
INTERSECTION W.S. 123.000 AND 15% SPAR
W.R.P. Z=-7.500
355.982
369.973
387.618
388.117
FWD HOOK BEARING AND CONTROL PT.
AFT HOOK BEARING AND CONTROL PT.
HOOK BEARING SURFACE
Z=-21.776
Z=-22.898
Z=-22.410
.550
2°
14.000
32.155
GEOMETRY-HOOK BEARING POINTS W.S. 123.000 PYLON (NO SCALE)
SYM ABOUT ℄
INTERSECTION W.S. 93.500 AND 15% SPAR
FWD HOOK BEARING AND CONTROL PT.
Z=-22.191
Z=-22.435
GEOMETRY-HOOK BEARING POINTS
ARMAMENT REF LINE
BARREL MUZZLE F.S. 118.090 Z=7.555 B.L.=10.750
STRUT DOOR AT MAX. MAIN GEAR COMPRESSION
CASE EJECTION CHUTE
SPEED BRAKE MAX. DOWN POSITION (REF)
AFT HRL
FWD HRL
.45 REF
℄ PYLON
CASE EJECTION PATH
M.L.G. AXLE COMPRESSED Z=-45.500
M.L.G. AXLE STATIC Z=-47.50
MAIN GEAR DOOR
SPEED BRAKE MAX. DOWN POSITION (REF)
CASE EJECTION CLEARANCE AT F.S. 250.0 AT F.S. 300.0
GROUND LINE-STATIC AT M.L.G. Z=-58.00
W.S. 71.100
W.S. 93.500
W.S. 123.000
FWD HOOK POINT
F.S. 355.982 Z=-22.898
F.S. 365.903 Z=-22.435
AIM-9 LAUNCHER SEE LAYOUT 14-082001
AFT HRL
WING R.P.
GROUND LINE-RIGHT GEAR STATIC, LEFT GEAR COMPRESSED, LEFT TIRE FLAT
GROUND LINE-MAIN GEAR & NOSE L.G. COMPRESSED ALL TIRES FLAT Z=-54.50
42.500
ELEVATION PIVOT
GUN BORE LINE
BARREL STABILIZER Z=8.235
M-39 20MM GUN 280 ROUNDS PER GUN
STRUT DEFLATED
STRUT INFLATED
NOSE GEAR
12
11
10
9
8
7
14-080000

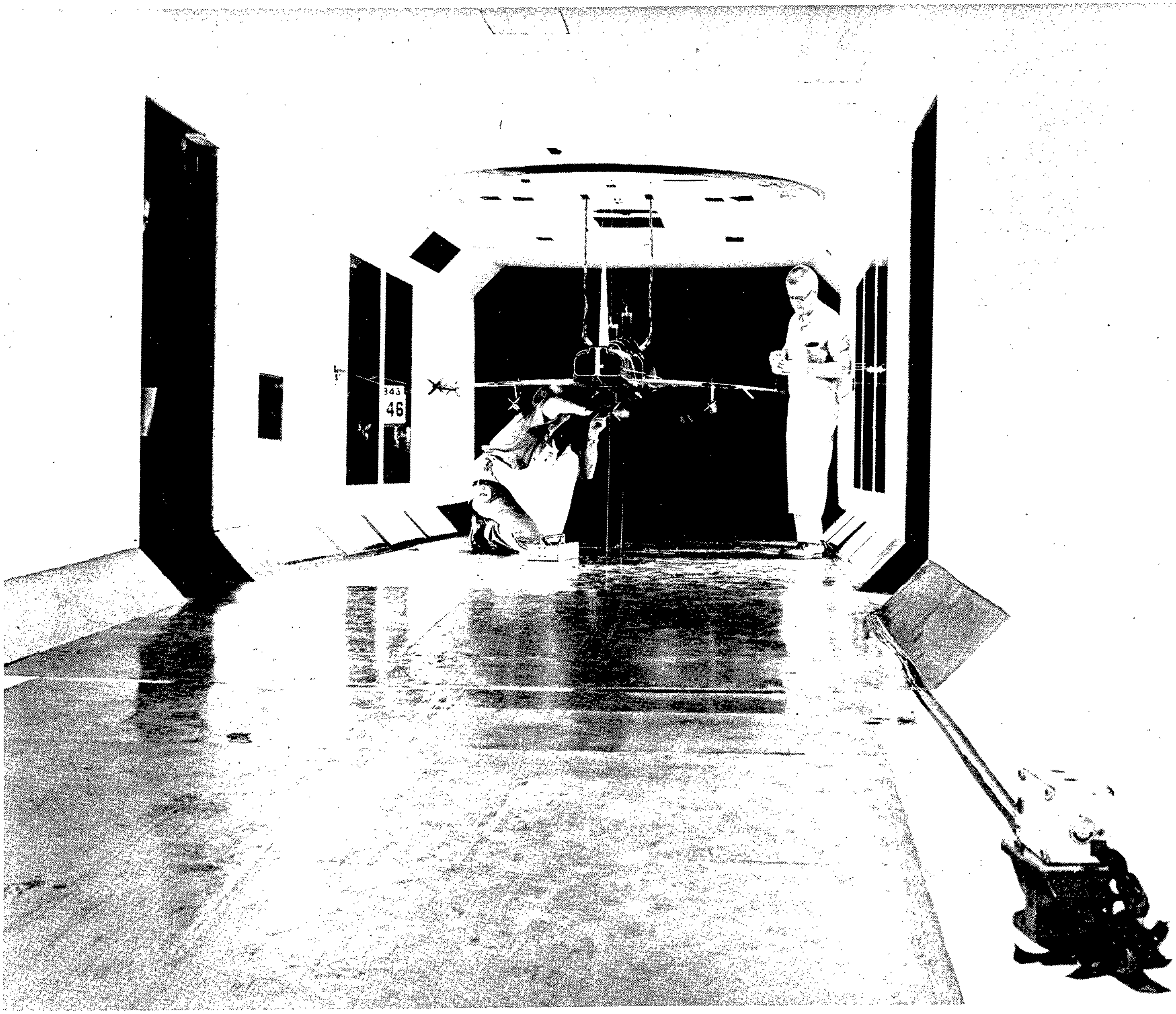


FIGURE 3 F-5E FLUTTER MODEL - AFT VIEW

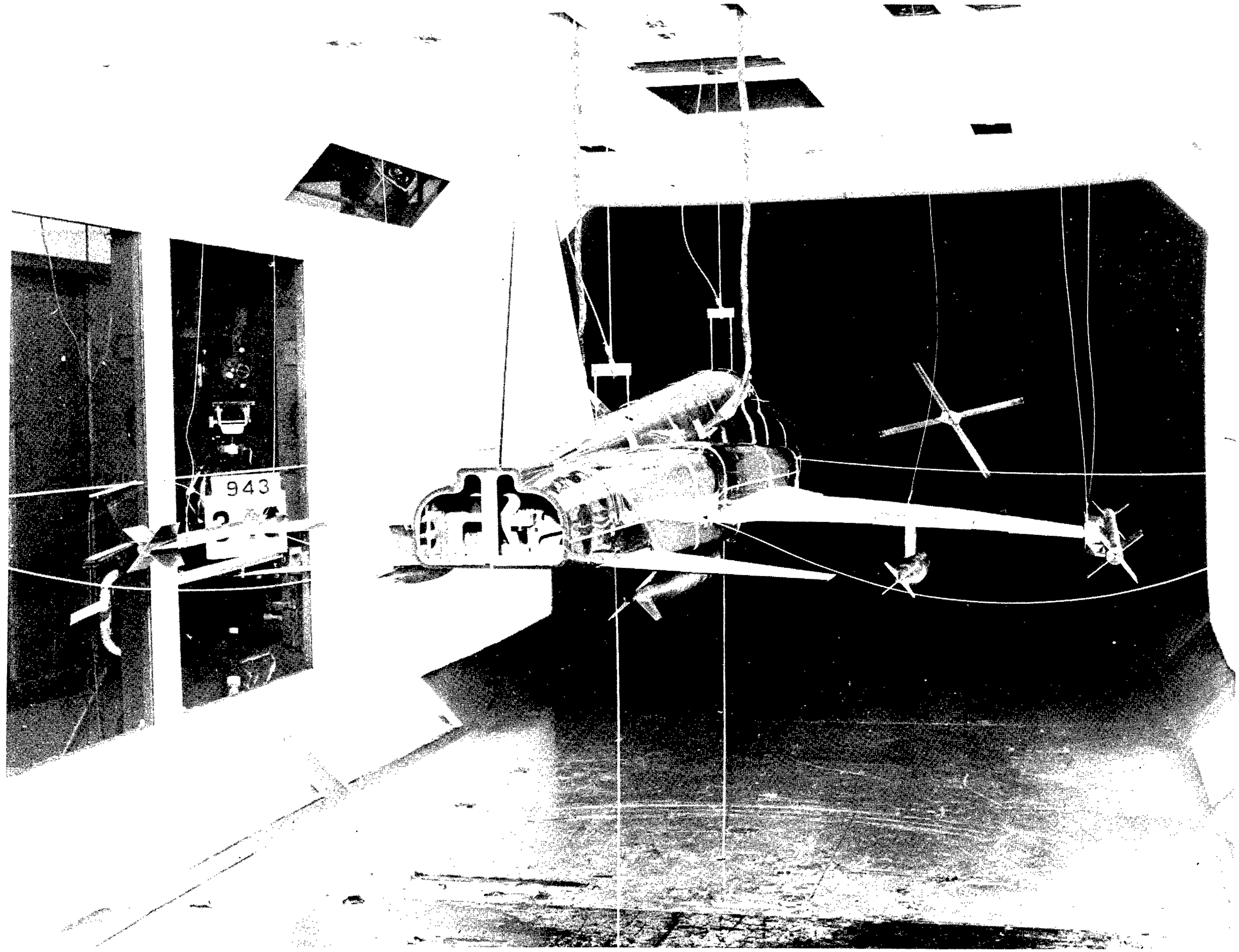


FIGURE 4. F-5E FLUTTER MODEL - RIGHT REAR VIEW

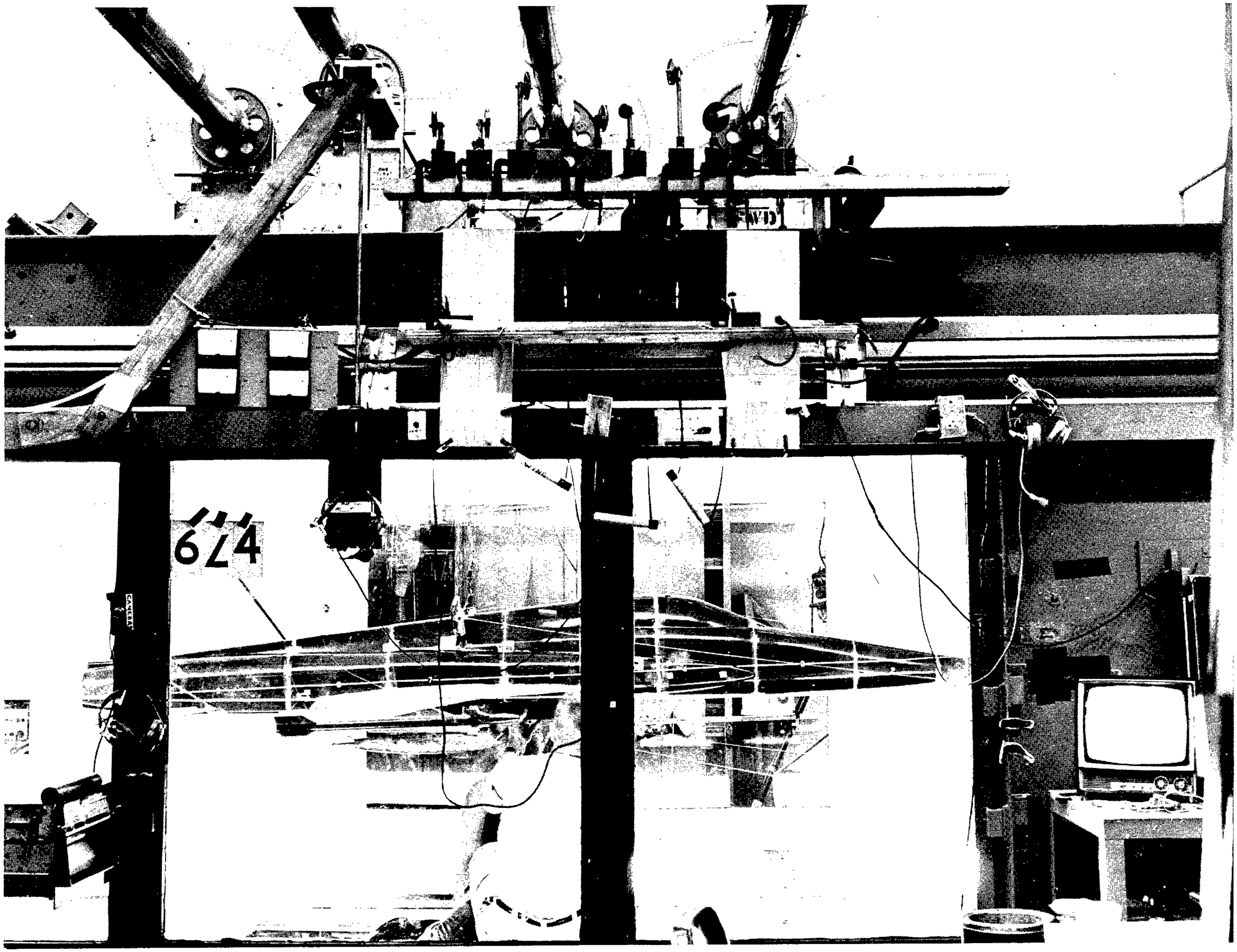


FIGURE 5. F-5E FLUTTER MODEL & SUSPENSION SYSTEM

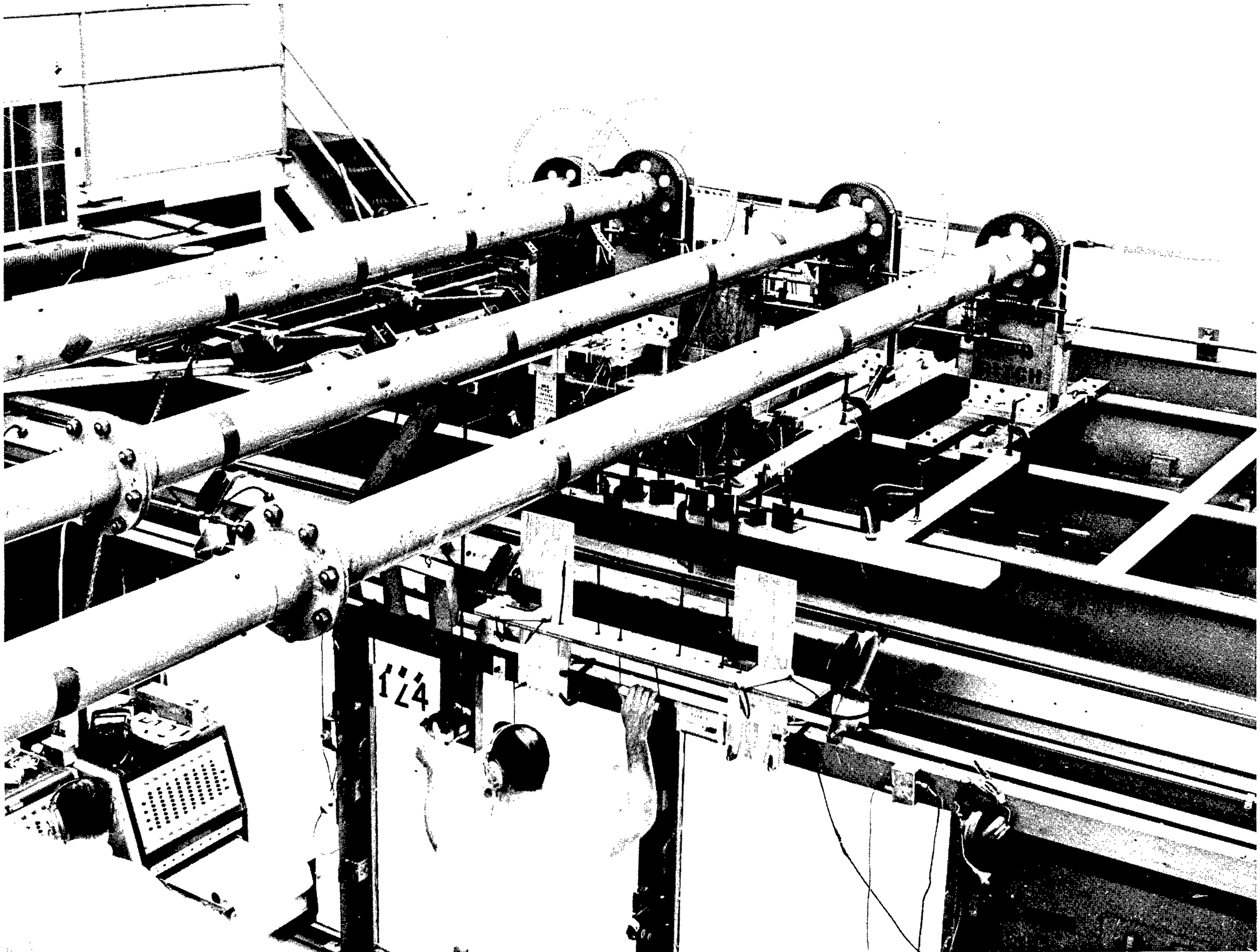


FIGURE 6. F-5E FLUTTER MODEL SUSPENSION SYSTEM

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CHECKER		REPORT NO. NOR 71-162
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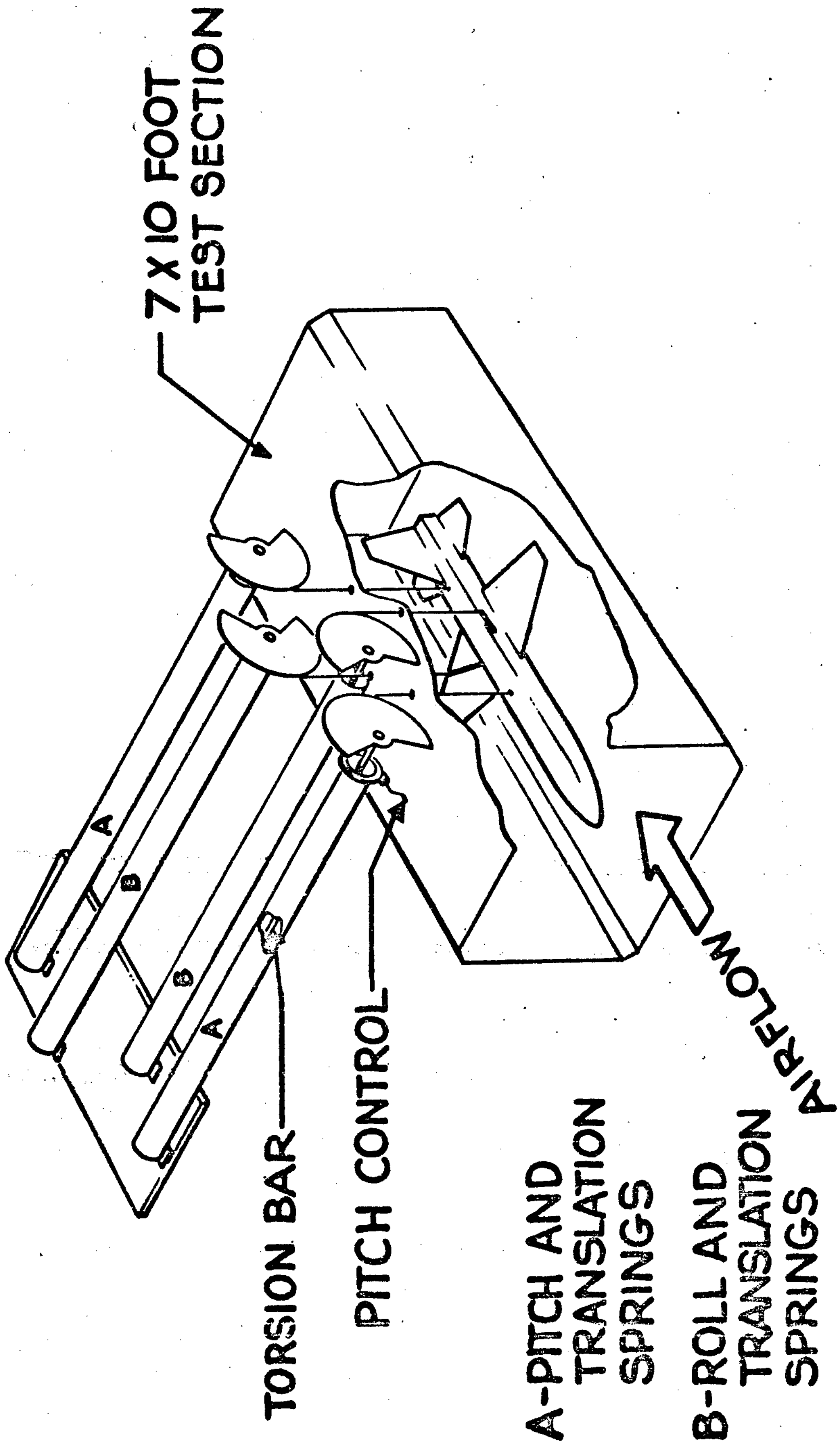

FORM 20-663
(R.8-69)

ENGINEER	Northrop Corporation Aircraft Division	PAGE 37
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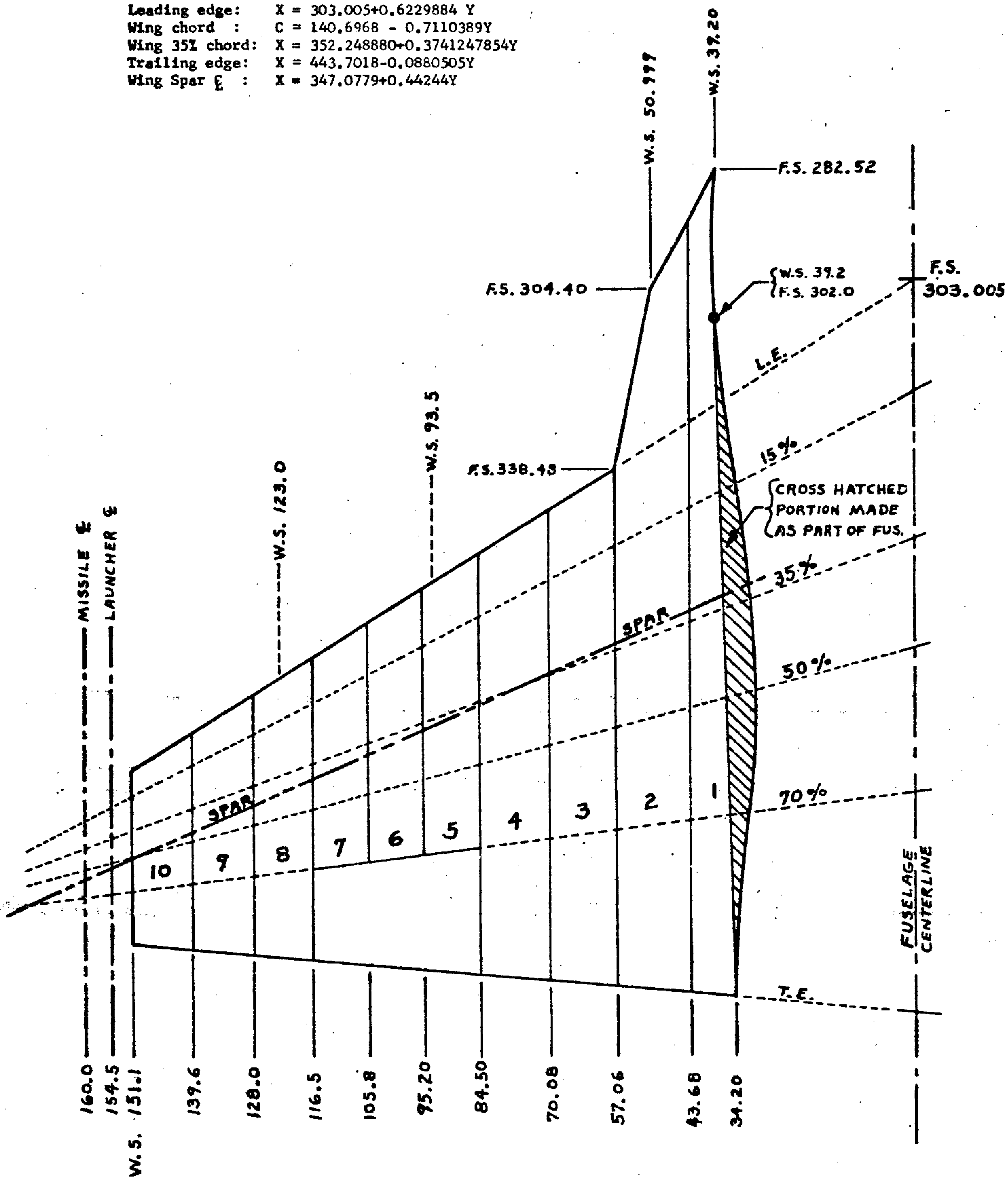
Equations:

Leading edge:	X = 303.005+0.6229884 Y
Wing chord :	C = 140.6968 - 0.7110389Y
Wing 35% chord:	X = 352.248880+0.3741247854Y
Trailing edge:	X = 443.7018-0.0880505Y
Wing Spar ℄ :	X = 347.0779+0.44244Y



FORM 20-663
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ENGINEER	Northrop Corporation Aircraft Division	PAGE 38
CHECKER		REPORT NO. NOR 71-162
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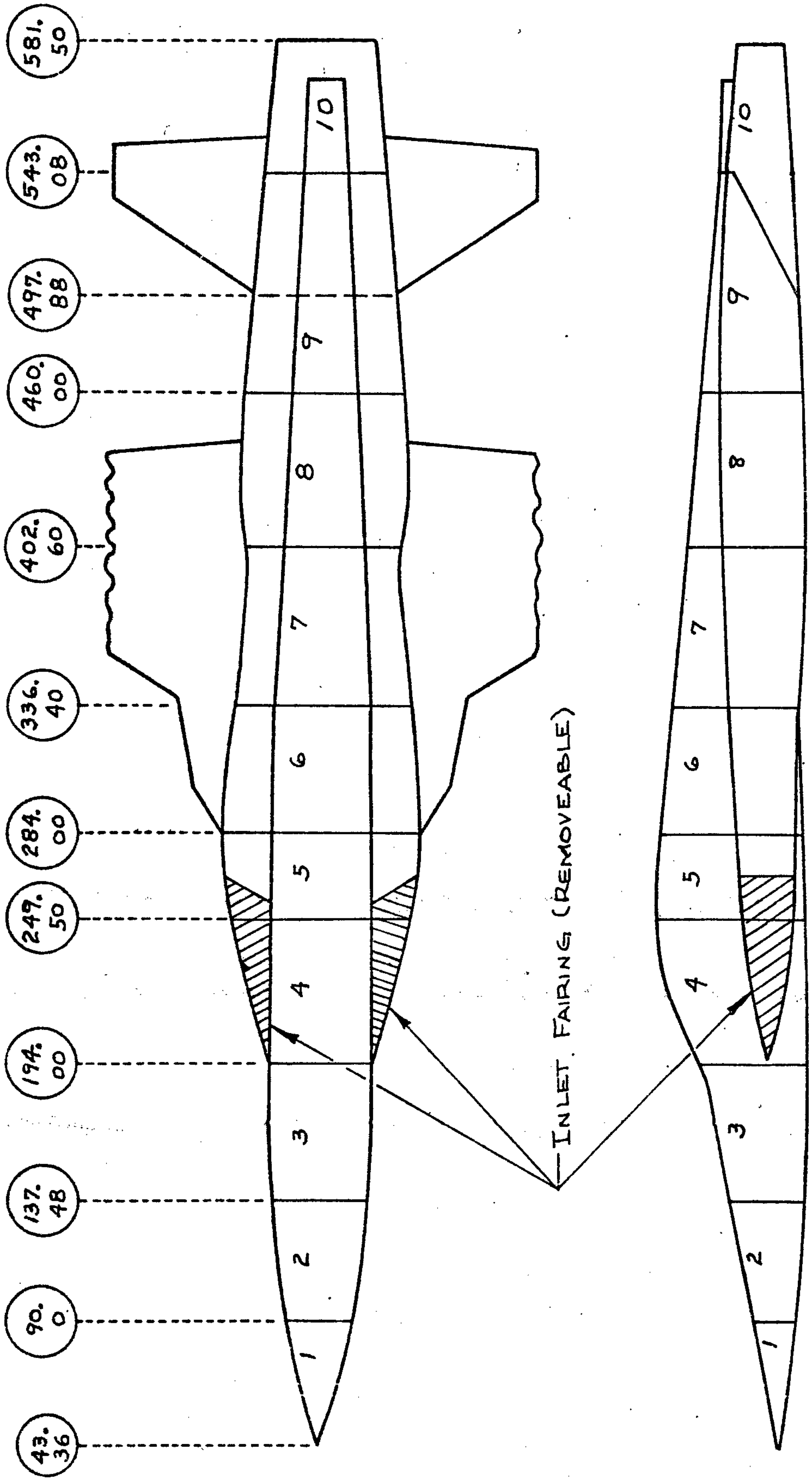

FORM 20-11A
(R. 6-69)

ENGINEER	Northrop Corporation Aircraft Division	PAGE 39
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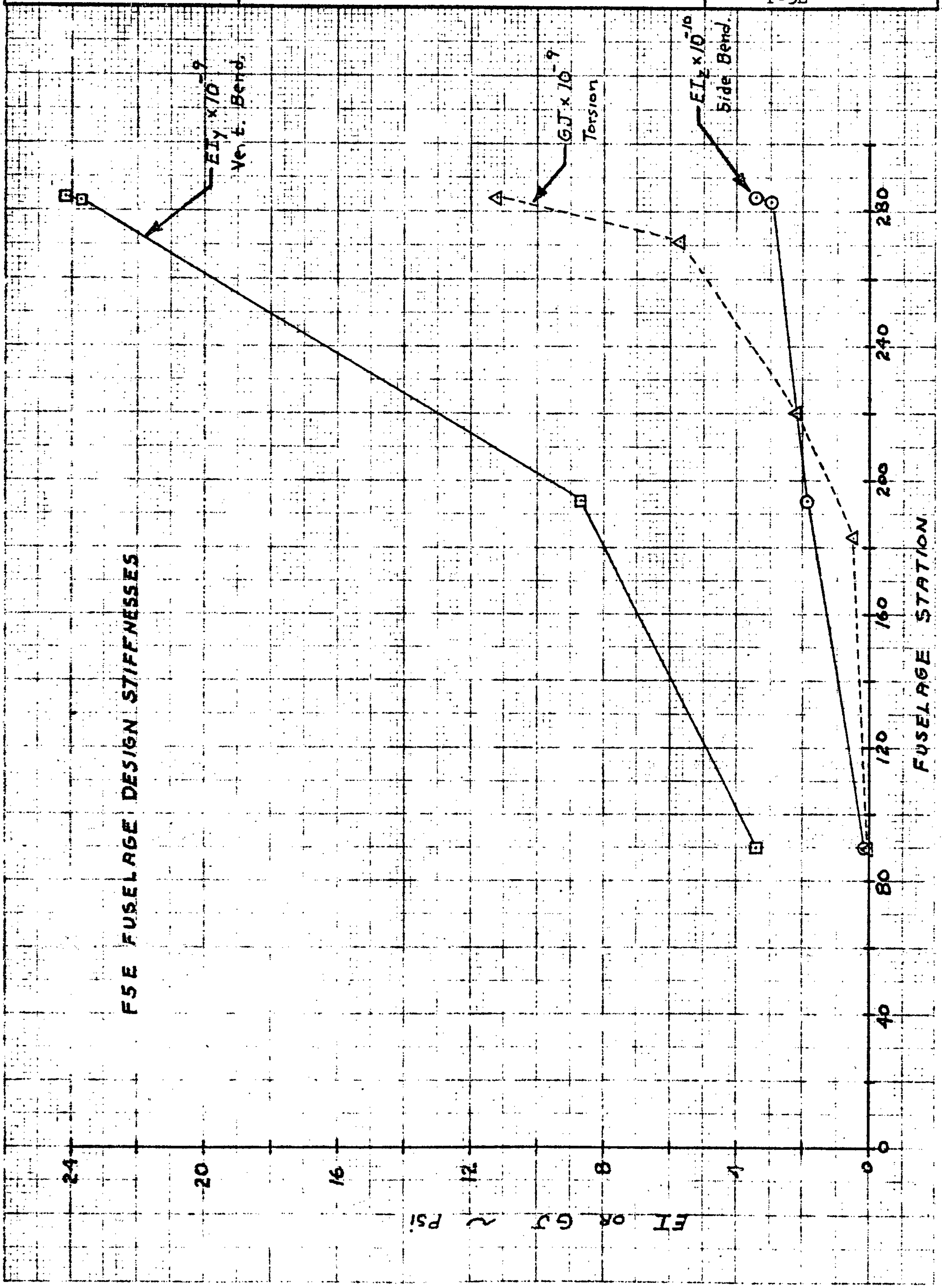

FORM 20-11A
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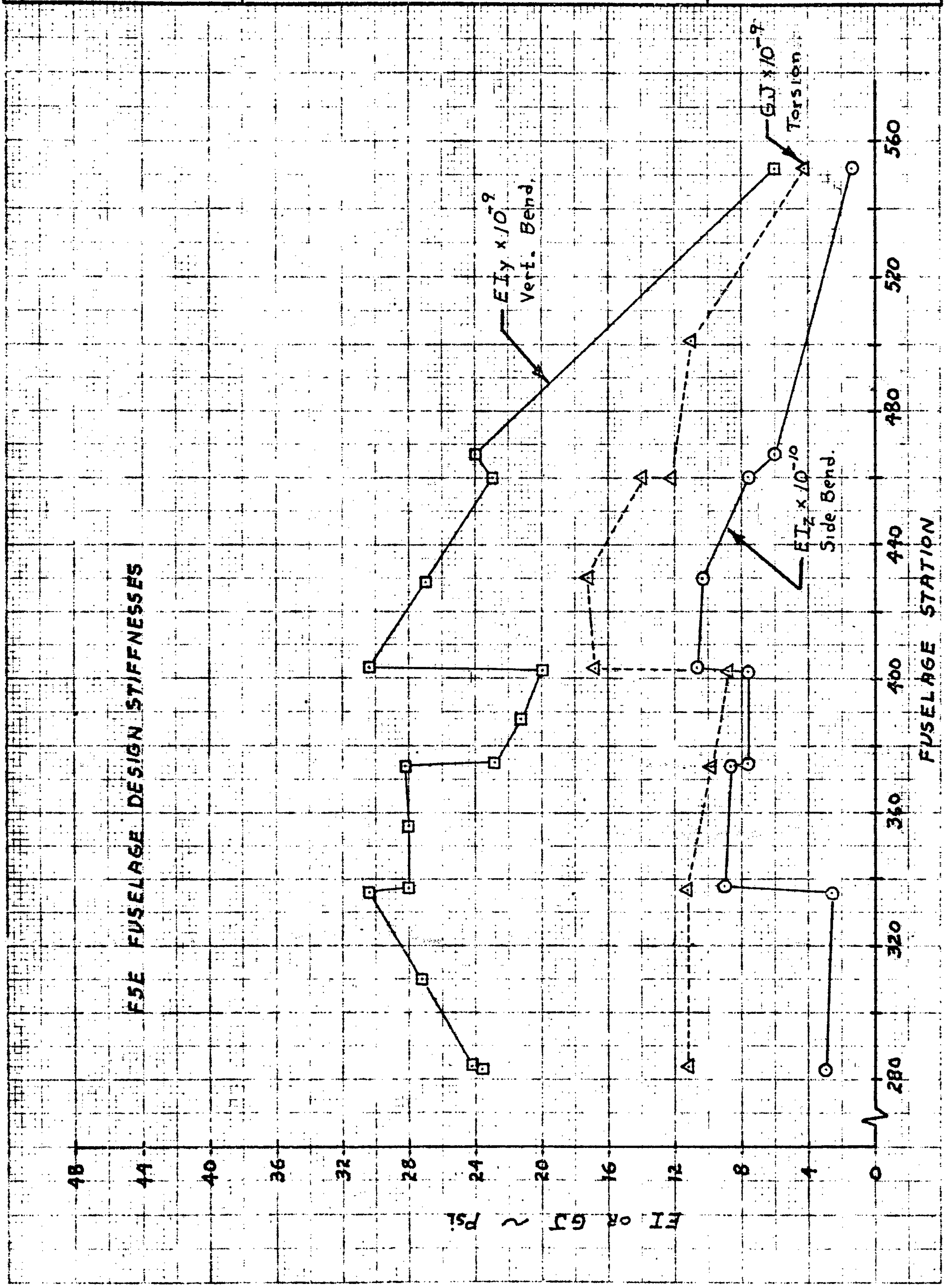

FORM 20-10A
(R.12-63)

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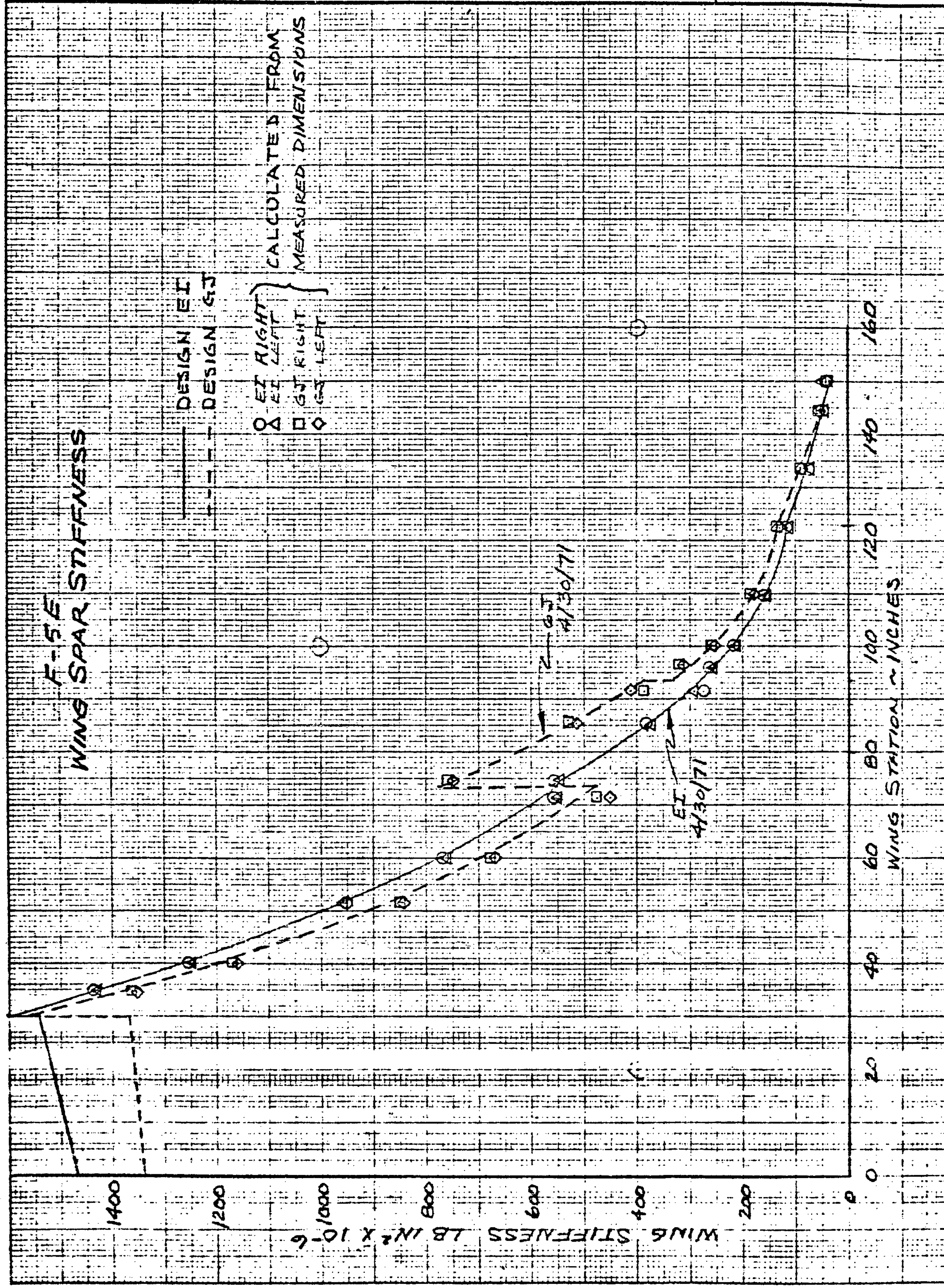

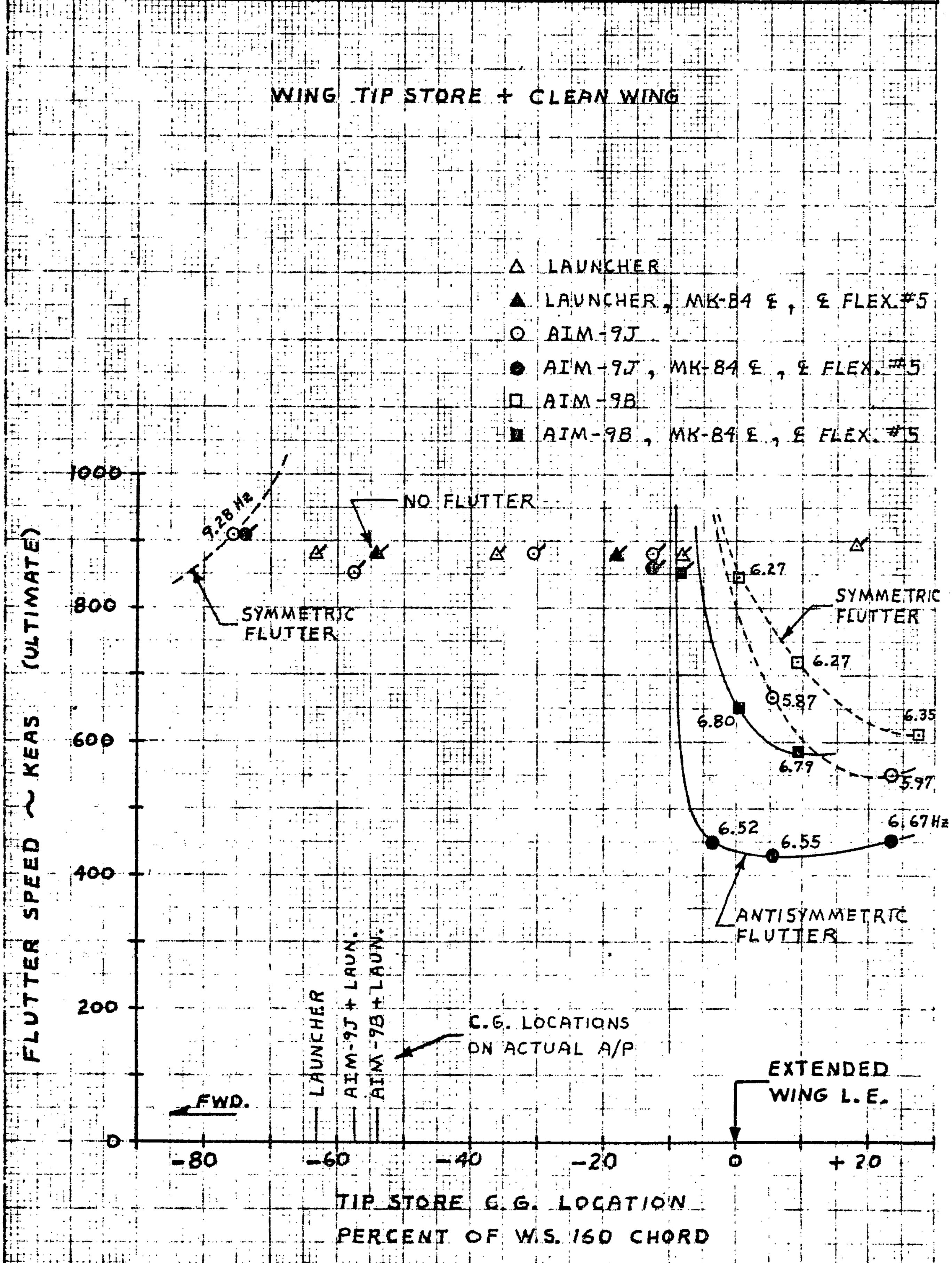
WING TIP STORE + CLEAN WING
LAUNCHER
LAUNCHER, MK-84 ℄, ℄ FLEX #5
AIM-9J
AIM-9J, MK-84 ℄, ℄ FLEX. #5
AIM-9B
AIM-9B, MK-84 ℄, ℄ FLEX. #5
NO FLUTTER
9.28 Hz
SYMMETRIC FLUTTER
6.27
6.27
5.87
6.80
6.79
6.35
5.97
6.52
6.55
6.67 Hz
ANTISYMMETRIC FLUTTER
LAUNCHER
AIM-9J + LAUN.
AIM-9B + LAUN.
C.G. LOCATIONS ON ACTUAL A/P
EXTENDED WING L. E.
FWD.
FLUTTER SPEED ~ KEAS (ULTIMATE)
1000
800
600
400
200
0
-80
-60
-40
-20
0
+20
TIP STORE C.G. LOCATION
PERCENT OF W.S. 160 CHORD

FORM 20-11A (R. 6-69)

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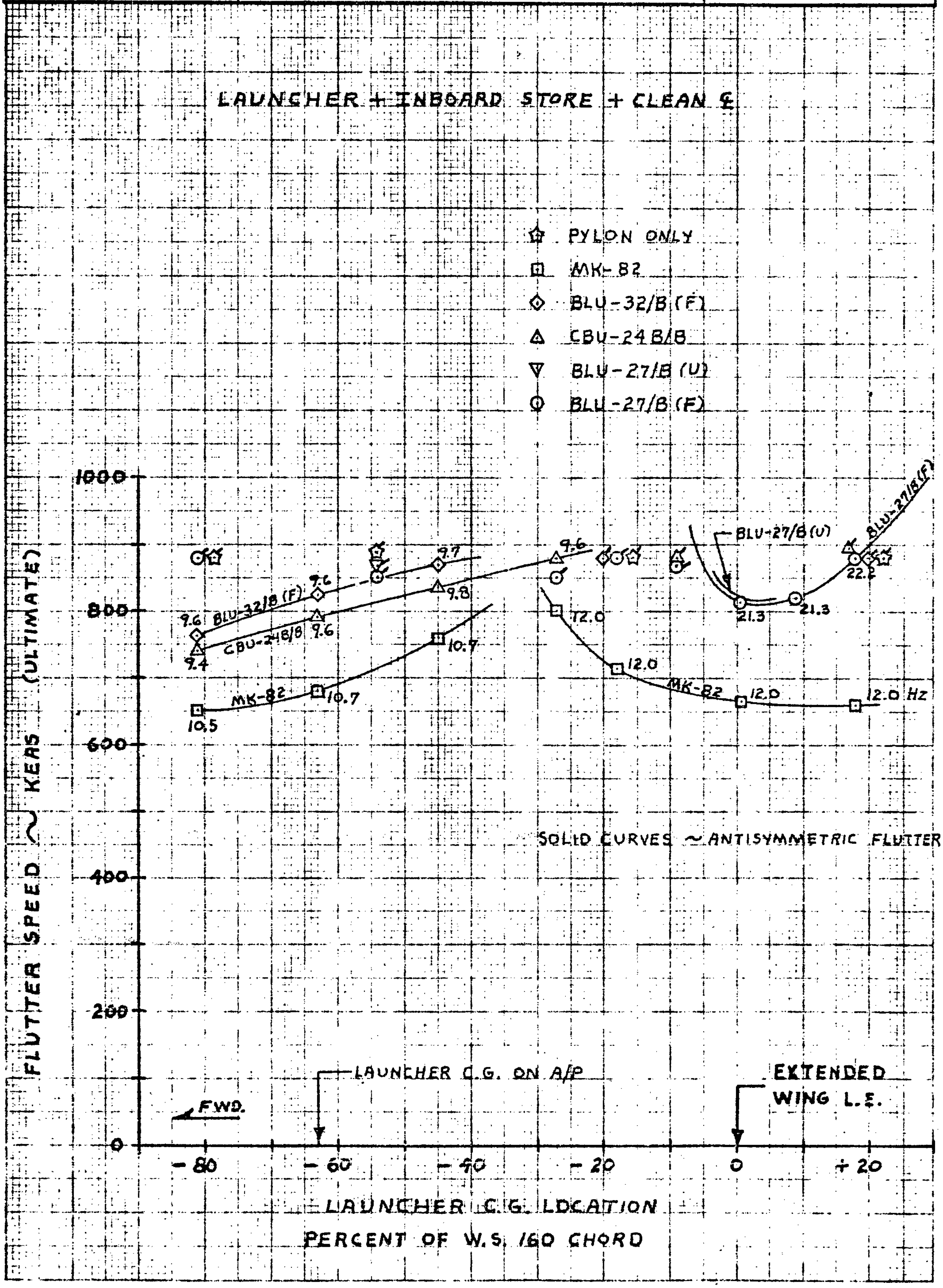

FORM 20-11A (R. 6-69)

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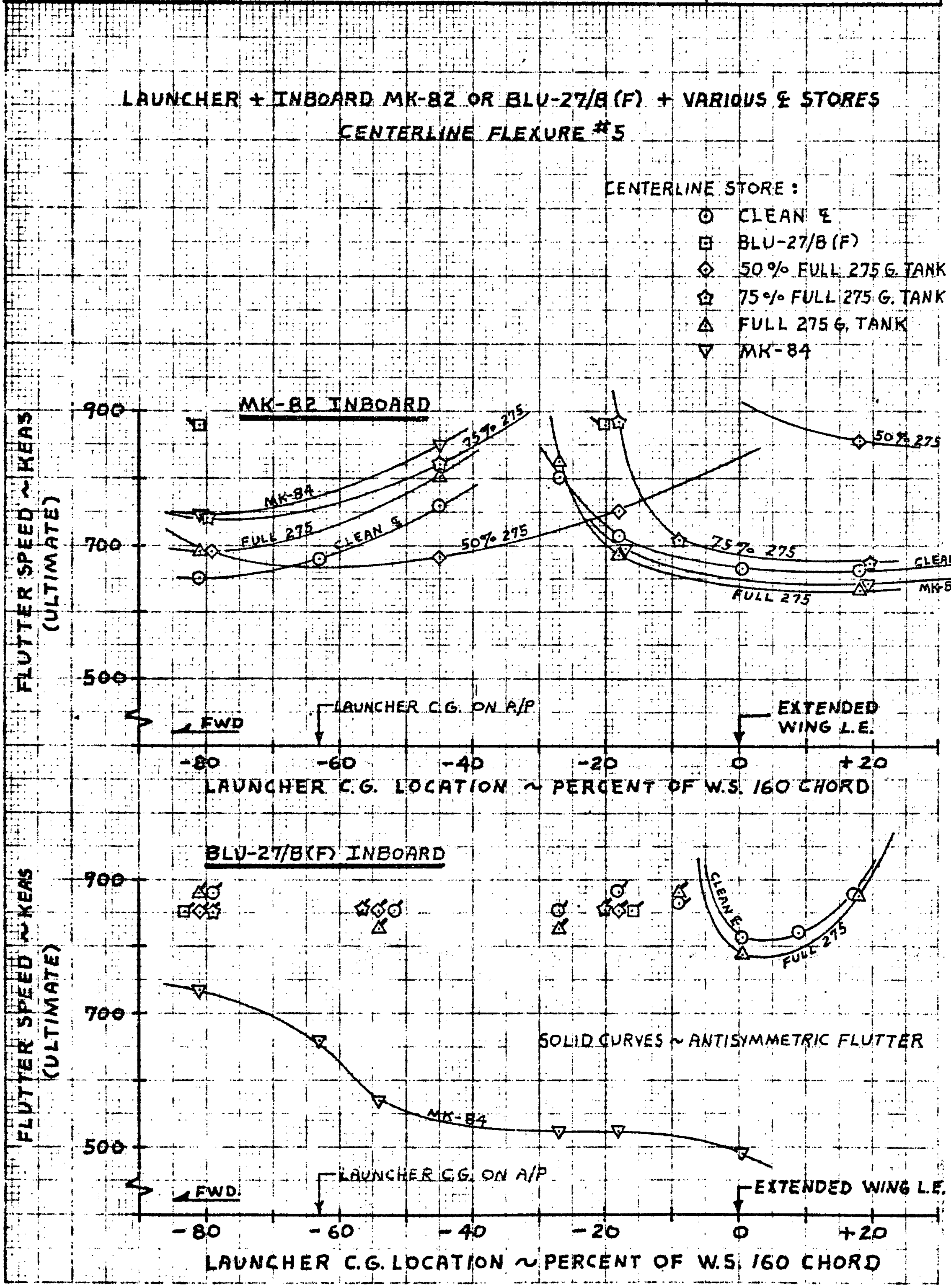

FORM 20-11A (R. 6-69)

ENGINEER	Northrop Corporation Aircraft Division	PAGE 45
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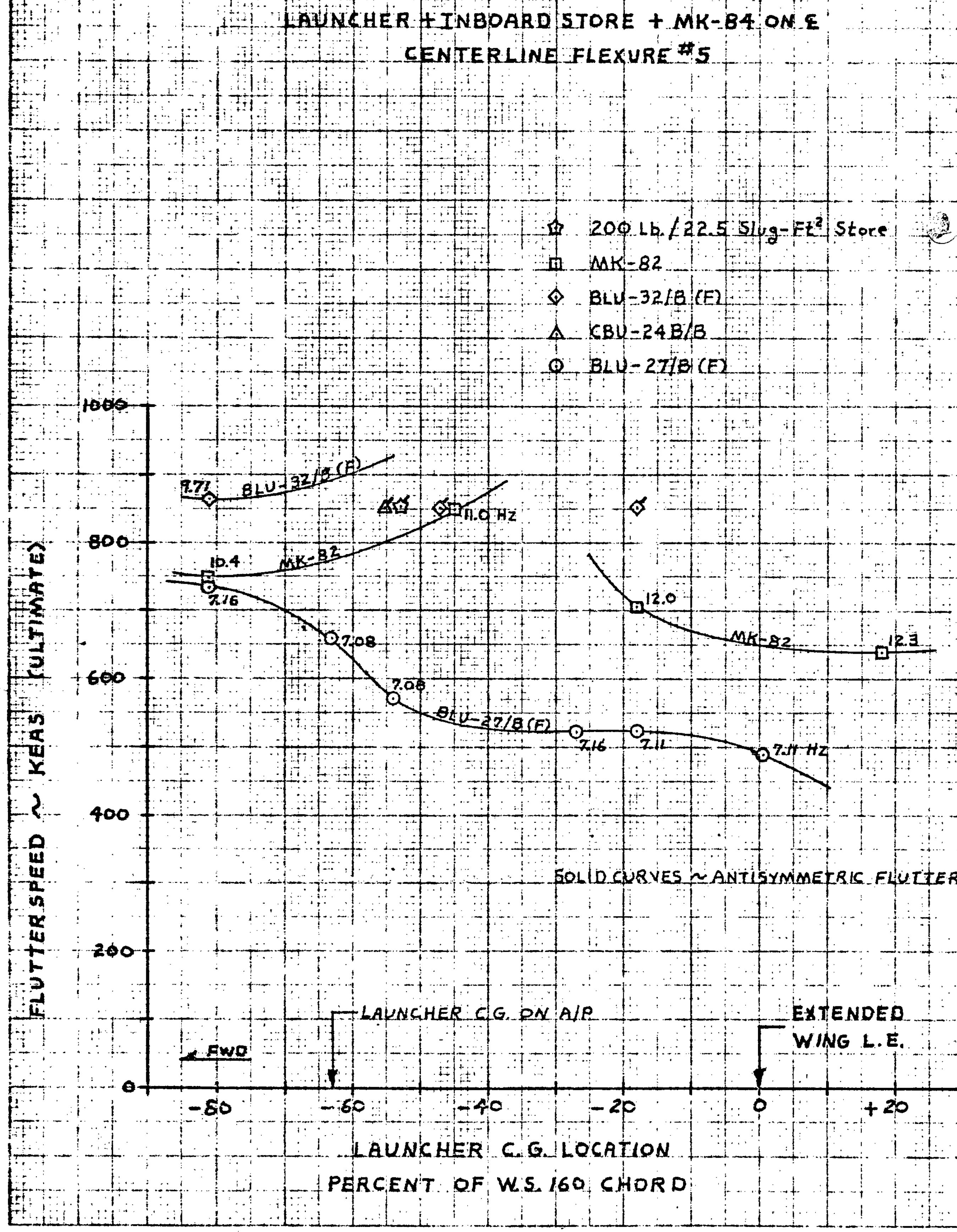

FORM 20-11A (R. 6-69)

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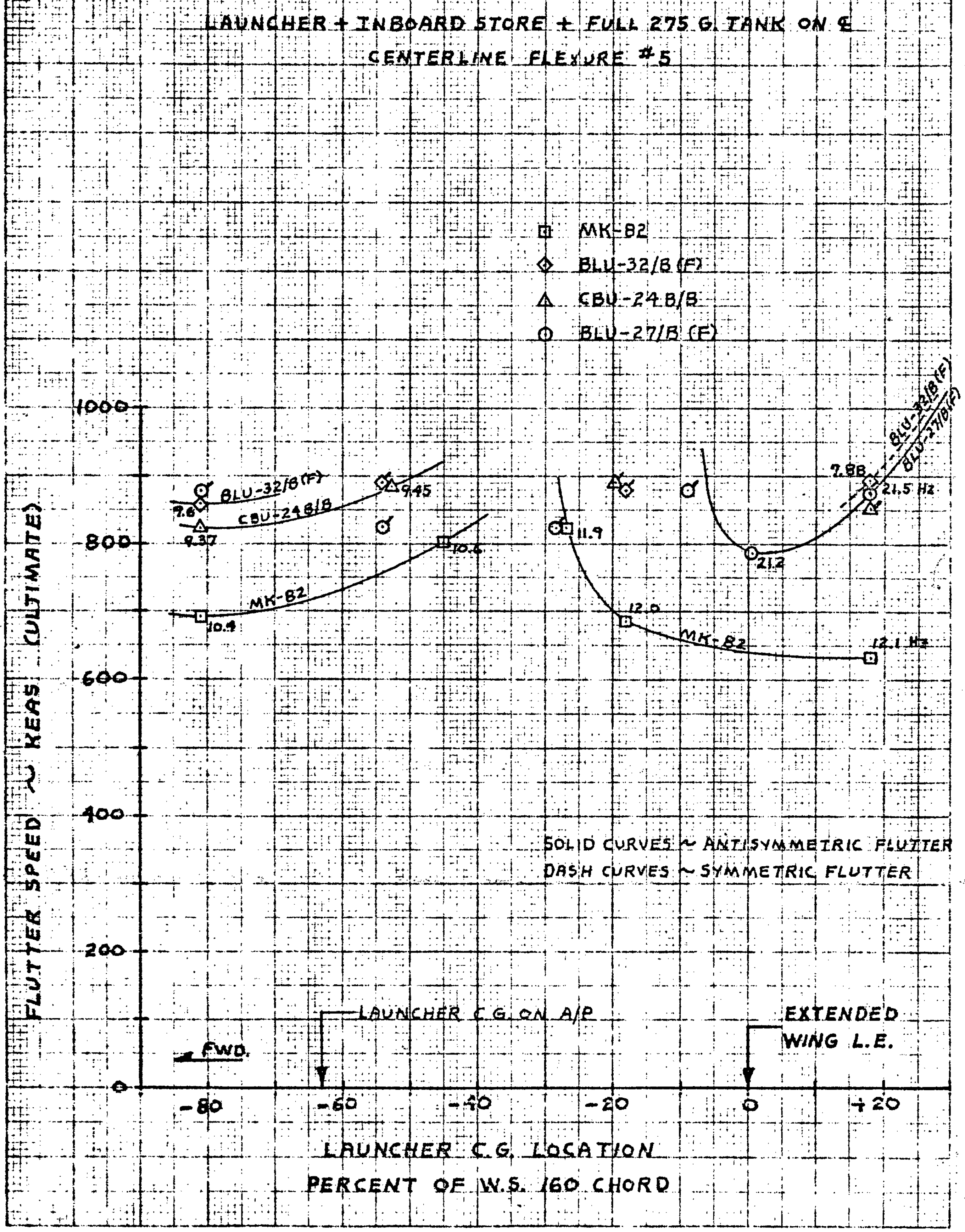
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 16	MODEL F-5E



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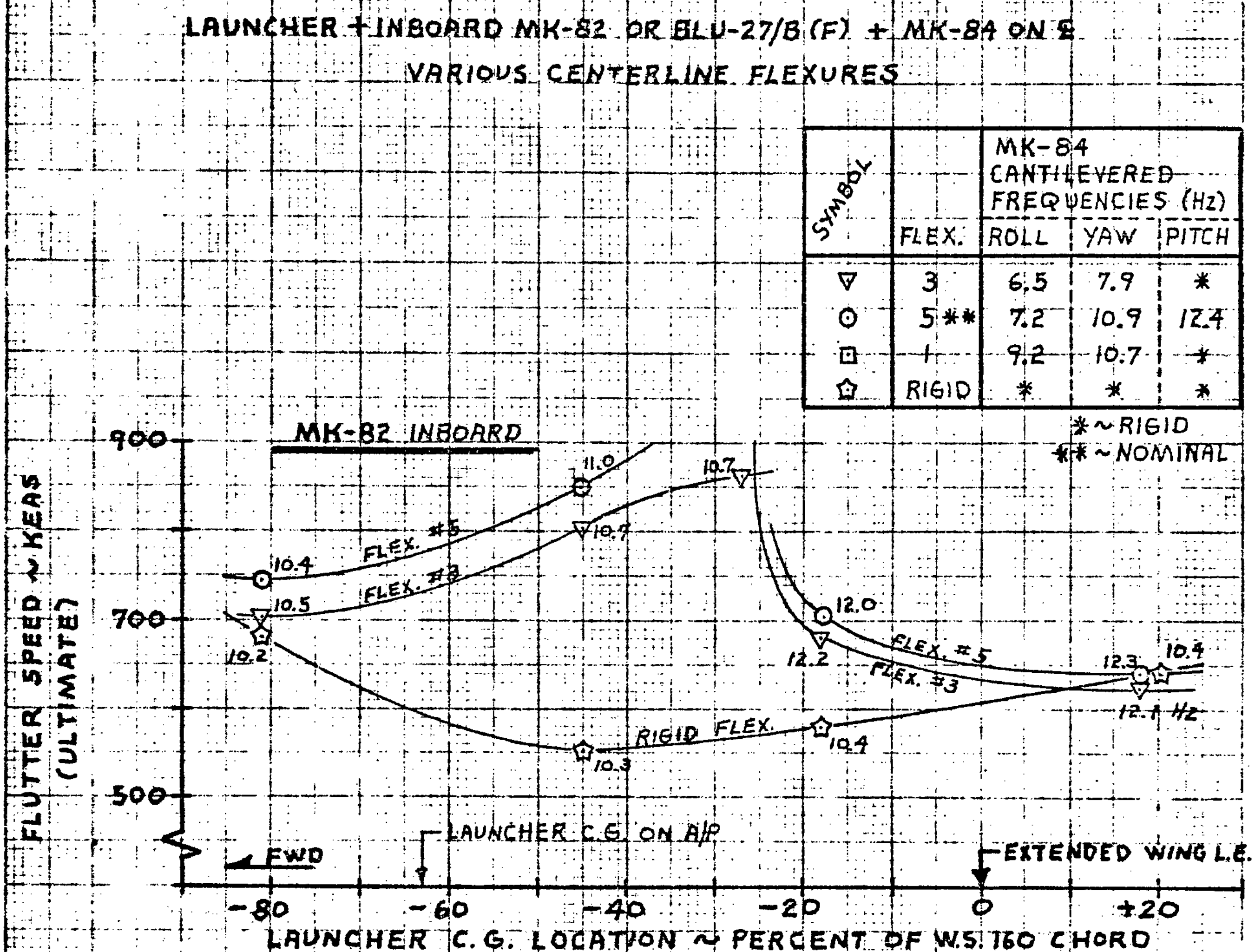
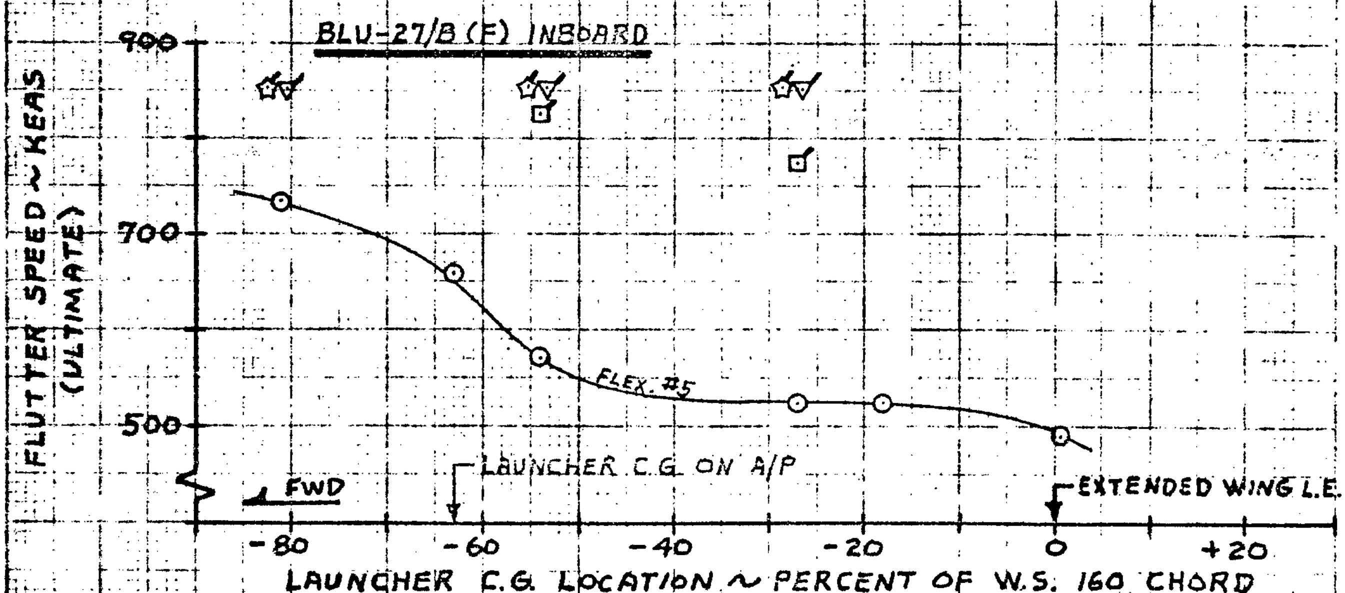
ENGINEER	Northrop Corporation Aircraft Division	PAGE 47
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 17	MODEL F-5E





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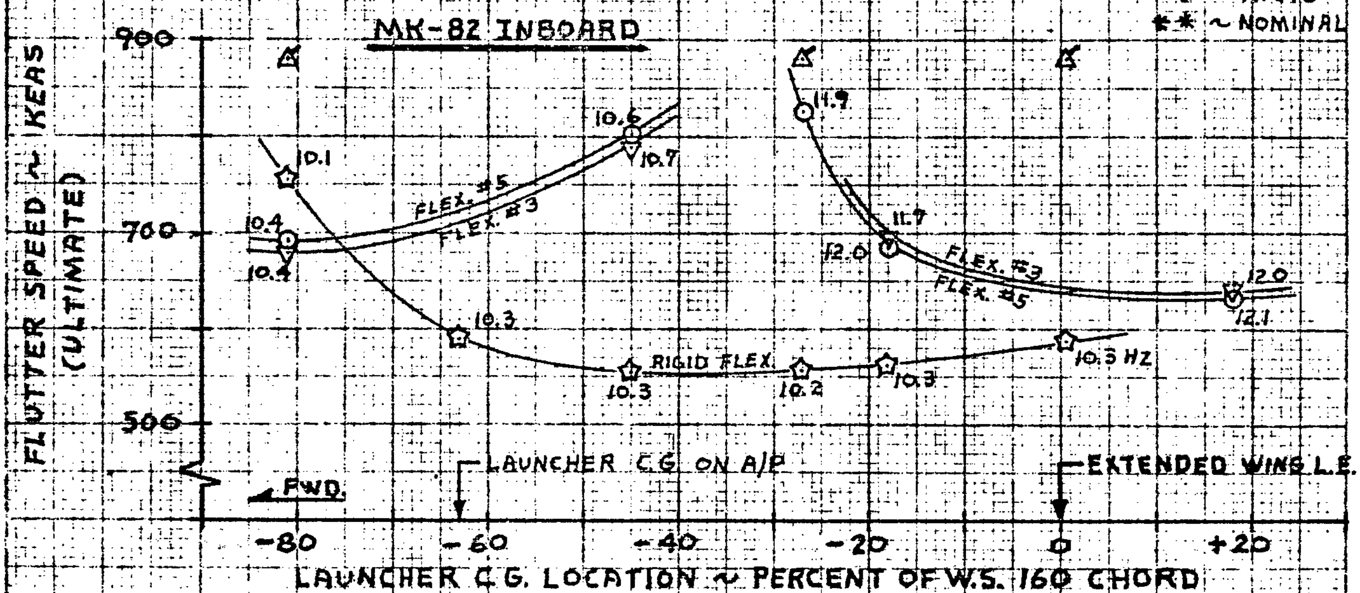
DATE	Figure 18	MODEL F-5E

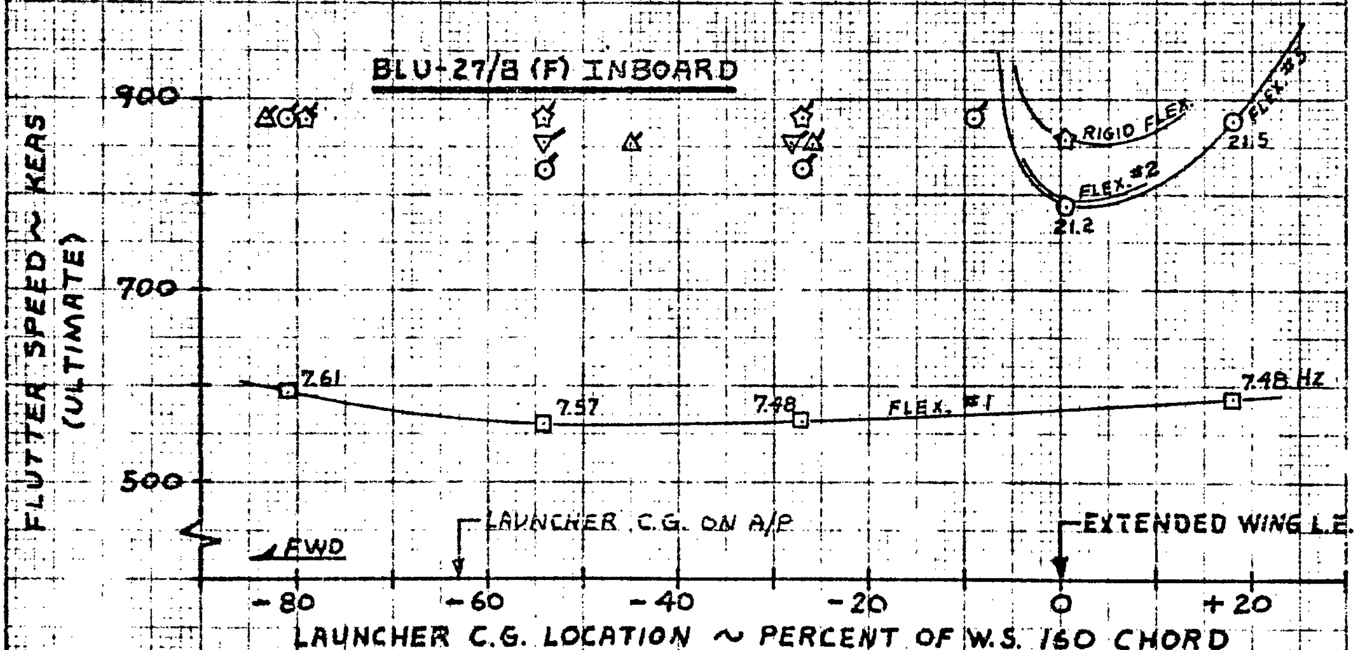
LAUNCHER + INBOARD MK-82 OR BLU-27/B(F) + FULL 275 G. TANK ON ℄

VARIOUS CENTERLINE FLEXURES

SYMBOL	FLEX.	FULL 275 G. TANK CANTILEVERED FREQUENCIES (Hz) ROLL	YAW	PITCH
▽	3	6.4	5.3	*
⊙	5 **	6.3	7.0	8.0
⊡	1	8.6	6.8	*
△	2	10.9	8.4	*
☆	RIGID	*	*	*

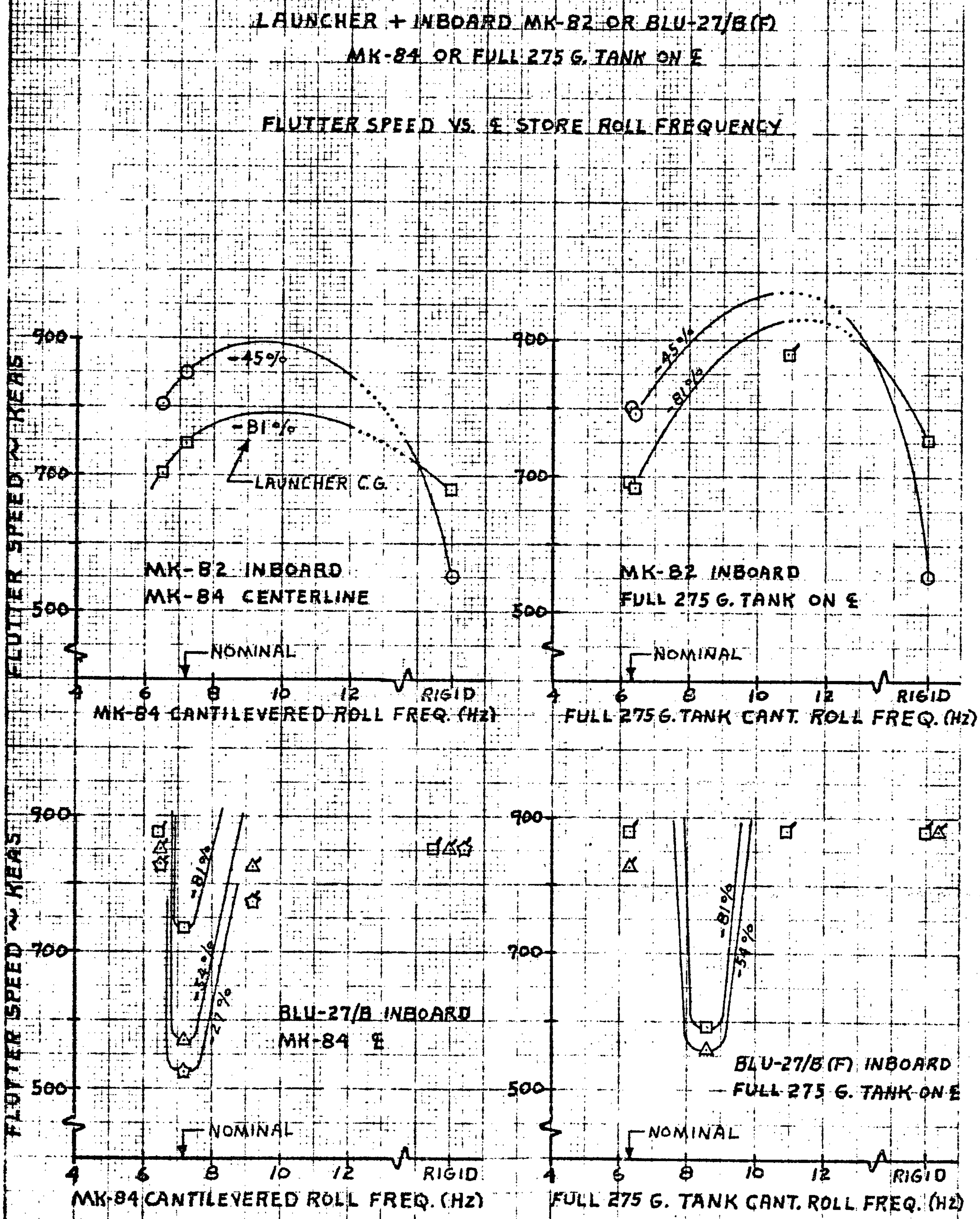
* ~ RIGID
** ~ NOMINAL





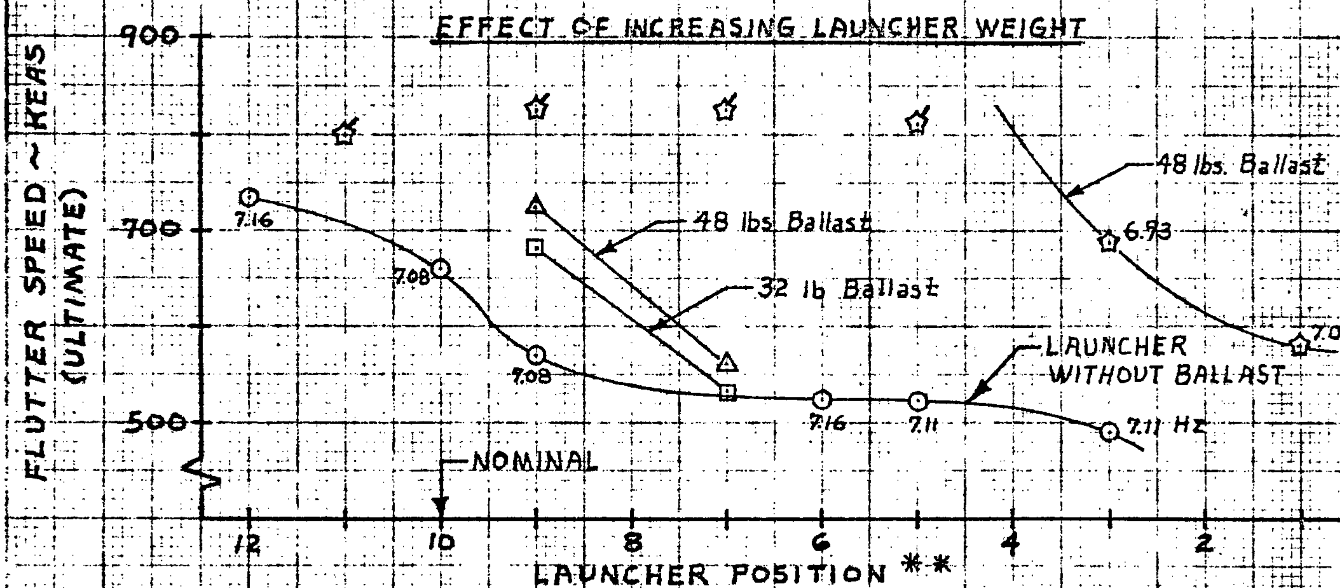
ENGINEER	Northrop Corporation Aircraft Division	PAGE 49
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 19	MODEL F-5E

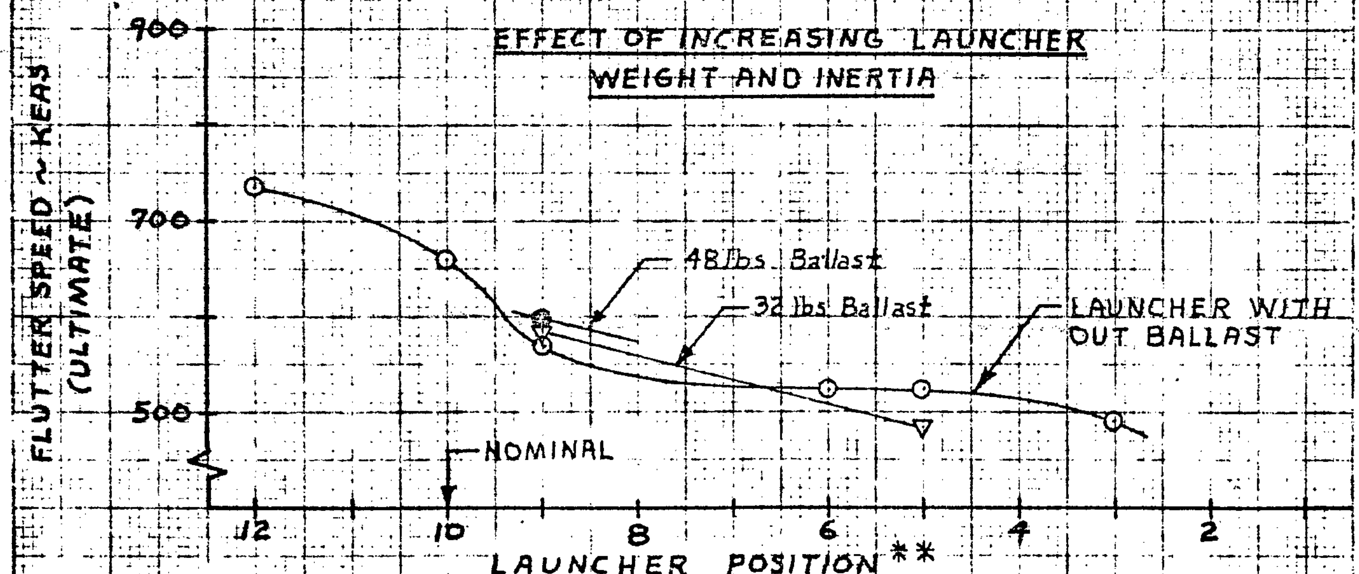
FORM 20-11A (R. 8-69)



LAUNCHER + INBOARD BLU-27/B (F)
MK-84 ON ℄
CENTERLINE FLEXURE #5

SYMBOL	LAUNCHER DATA Wt. lbs.	C.G. L.S.	I lb-in²
○	49.2	48.8	26289.
□	81.2	48.8	26289.
△	97.2	48.8	26289.
☆	97.2	33.98	48156.
▽	81.2	48.8	55089.
●	97.2	48.8	69489.





** SCREW HOLE THAT IS ALIGNED WITH FWD. LUG ON WING SPAR

NOTE: LAUNCHER POSITION IS IDENTIFIED BY GEOMETRICAL, RATHER THAN C.G. RELATED, COORDINATES SINCE THE LAUNCHER BALLAST IN SOME CASES CHANGES THE REFERENCE LAUNCHER C.G. LOCATION. INCREASING POSITION NO. MOVES LAUNCHER FWD.

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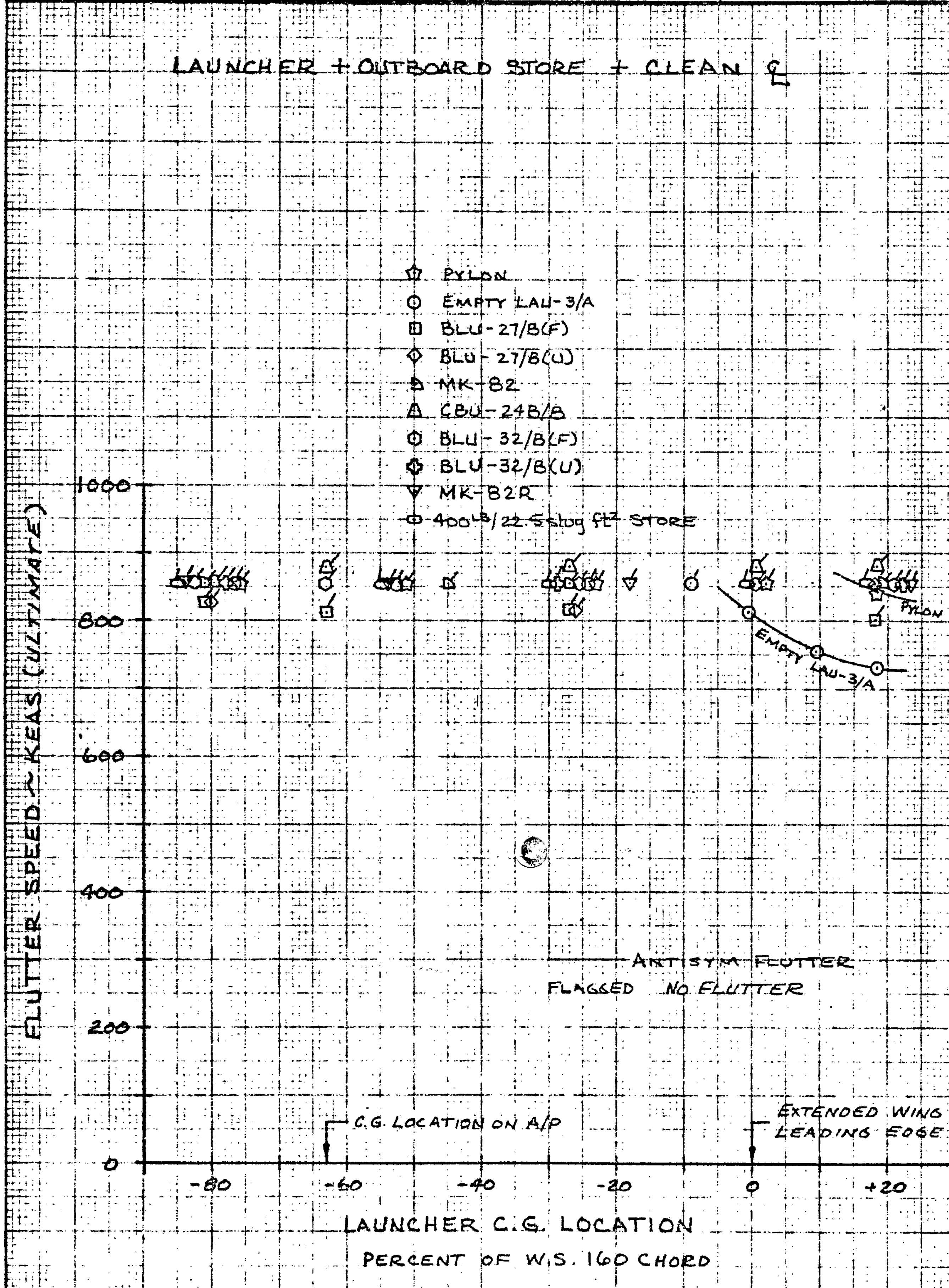
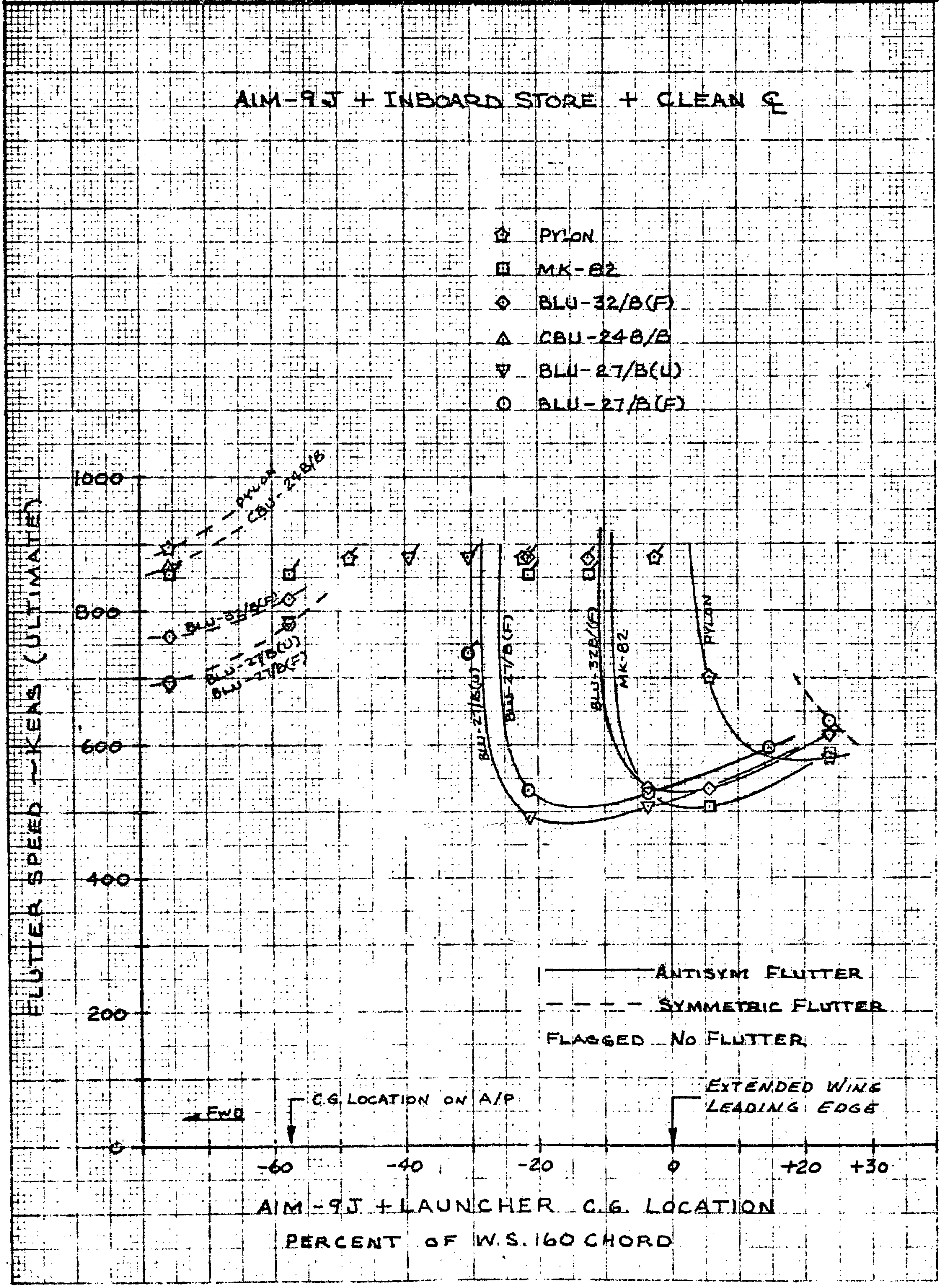
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 21	MODEL F-5E




AIM-9J + INBOARD STORE + CLEAN ℄
PYLON
MK-82
BLU-32/B(F)
CBU-24B/B
BLU-27/B(U)
BLU-27/B(F)
FLUTTER SPEED — KEAS (ULTIMATE)
1000
800
600
400
200
0
ANTISYM FLUTTER
SYMMETRIC FLUTTER
FLAGGED NO FLUTTER
FWD
C.G. LOCATION ON A/P
EXTENDED WING LEADING EDGE
-60
-40
-20
0
+20
+30
AIM-9J + LAUNCHER C.G. LOCATION
PERCENT OF W.S. 160 CHORD

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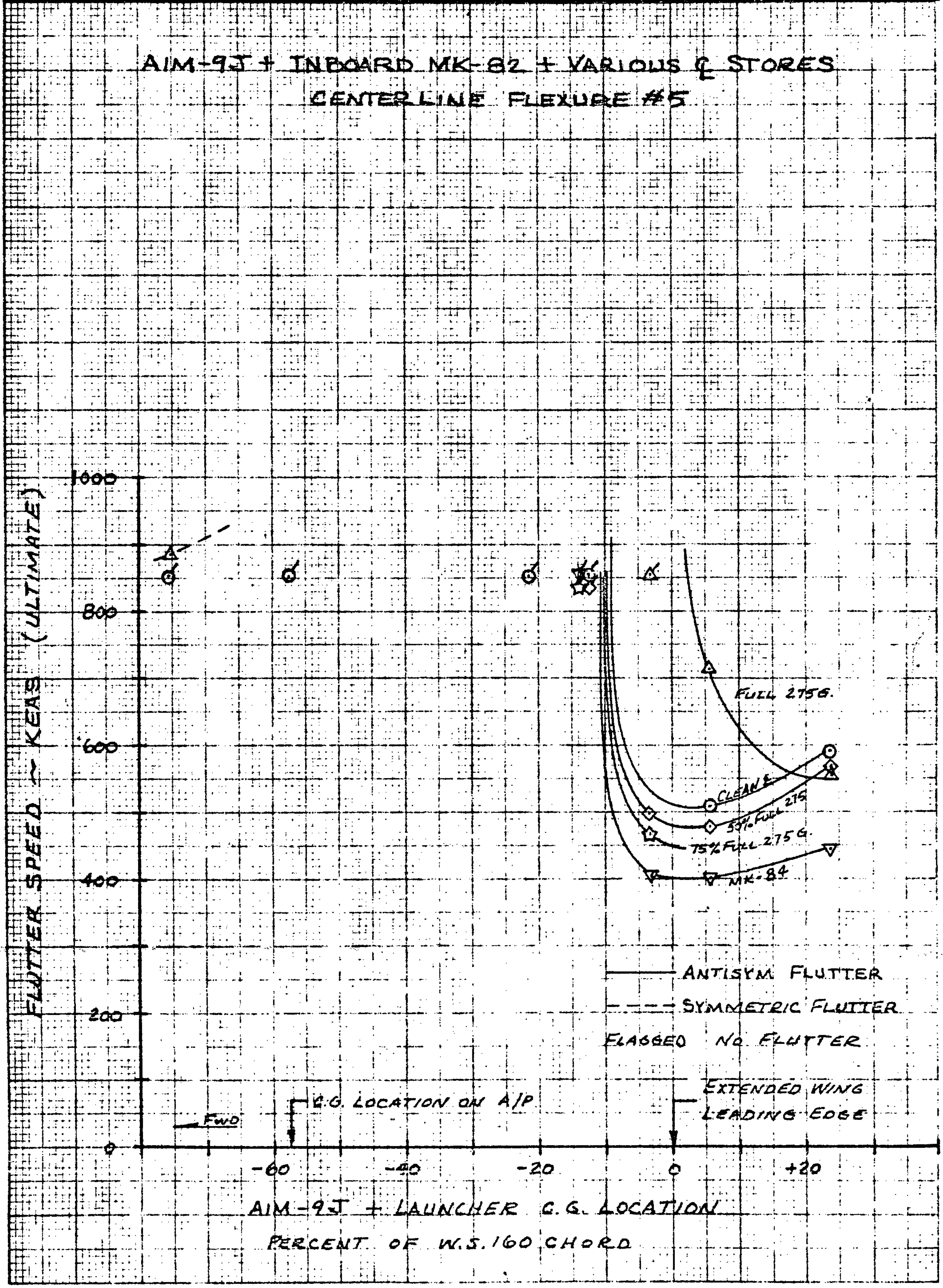
ENGINEER	Northrop Corporation Aircraft Division	PAGE 53
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 23	MODEL F-5E



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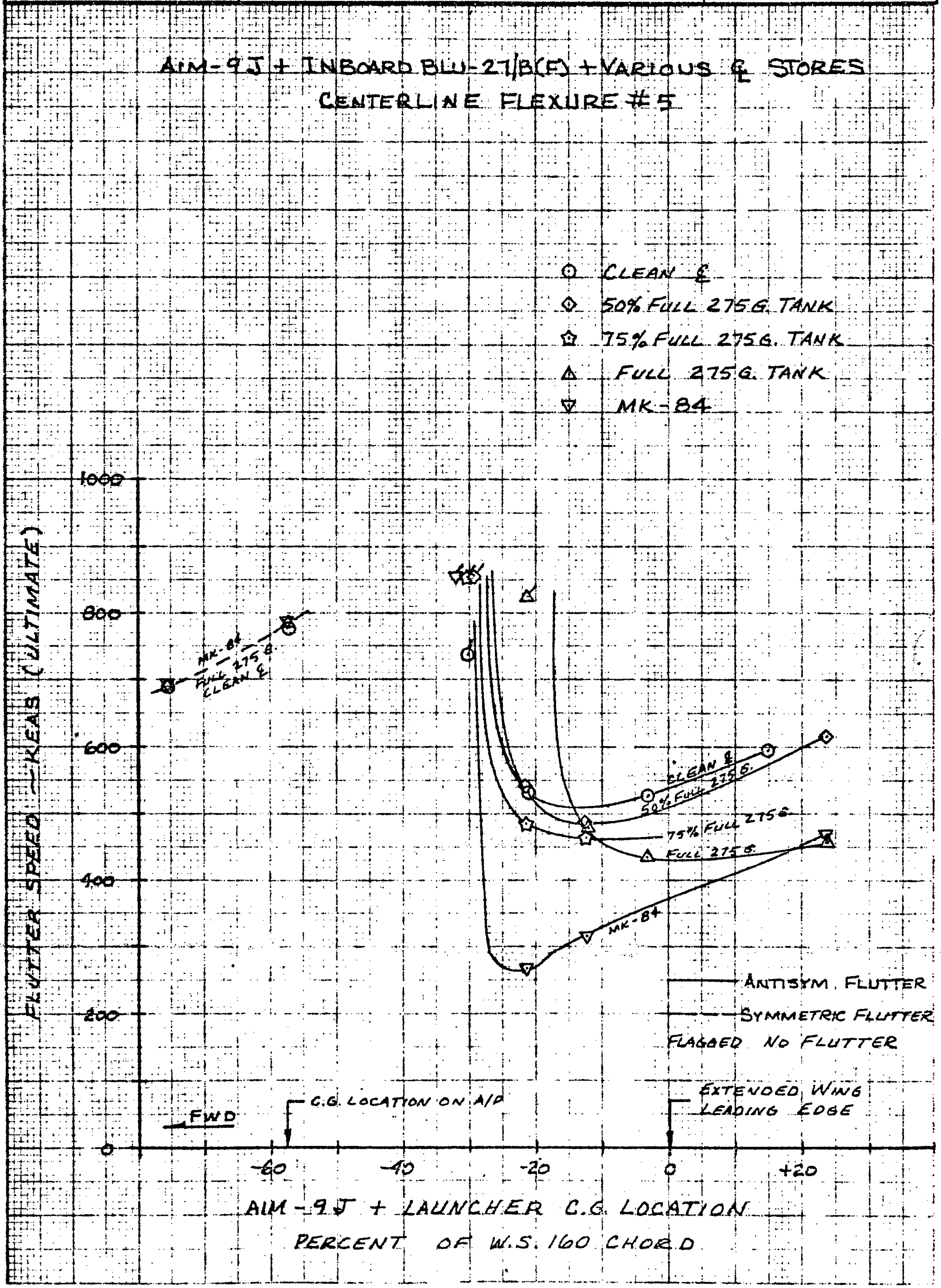
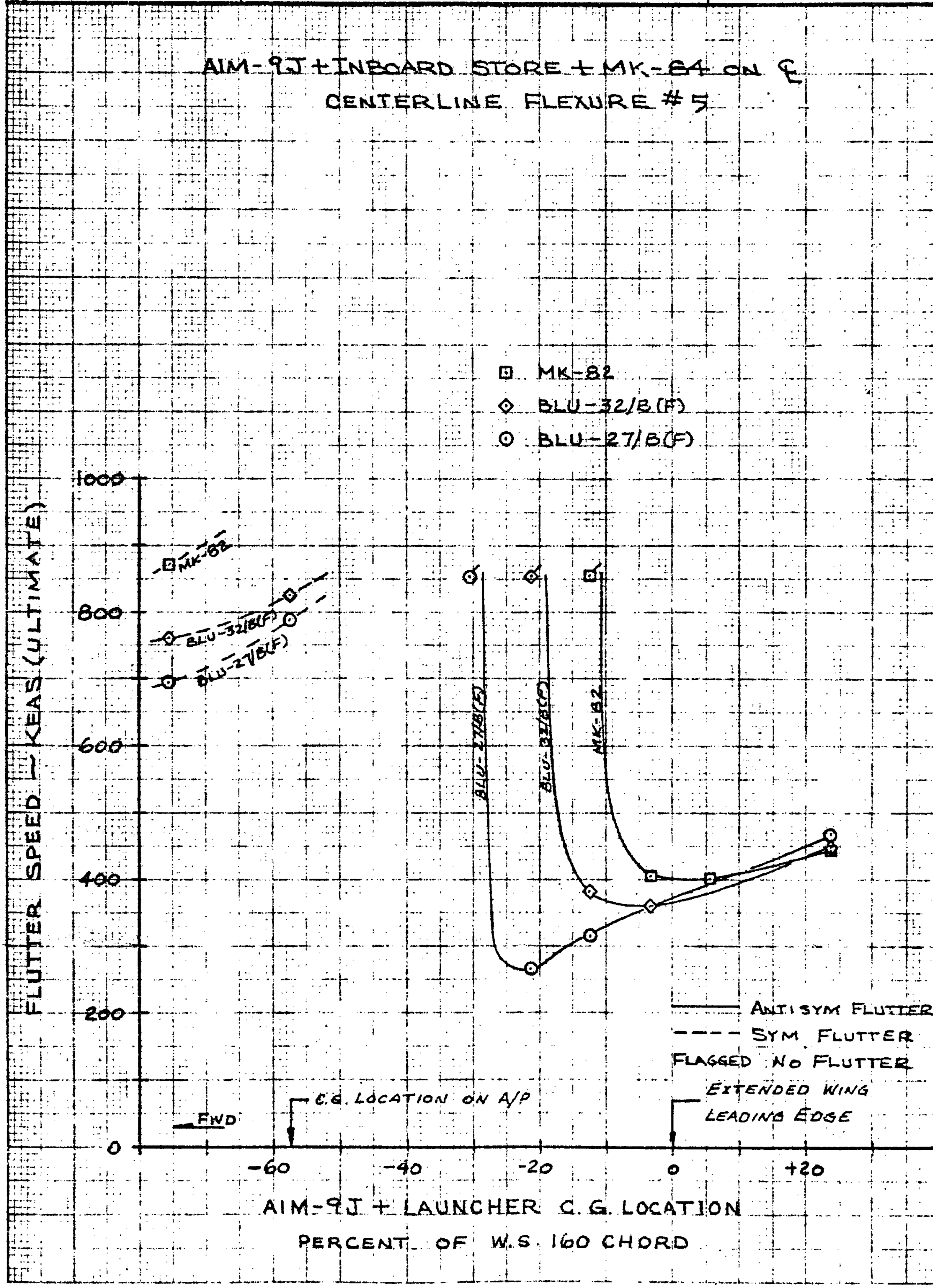
ENGINEER	Northrop Corporation Aircraft Division	PAGE 54
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 24	MODEL F-5E




AIM-9J + INBOARD STORE + MK-84 ON ℄
CENTERLINE FLEXURE #5
MK-82
BLU-32/B(F)
BLU-27/B(F)
FLUTTER SPEED — KEAS (ULTIMATE)
1000
800
600
400
200
0
MK-82
BLU-32/B(F)
BLU-27/B(F)
BLU-27/B(F)
BLU-32/B(F)
MK-82
ANTISYM FLUTTER
SYM FLUTTER
FLAGGED NO FLUTTER
EXTENDED WING
LEADING EDGE
C.G. LOCATION ON A/P
FWD
-60
-40
-20
0
+20
AIM-9J + LAUNCHER C.G. LOCATION
PERCENT OF W.S. 160 CHORD

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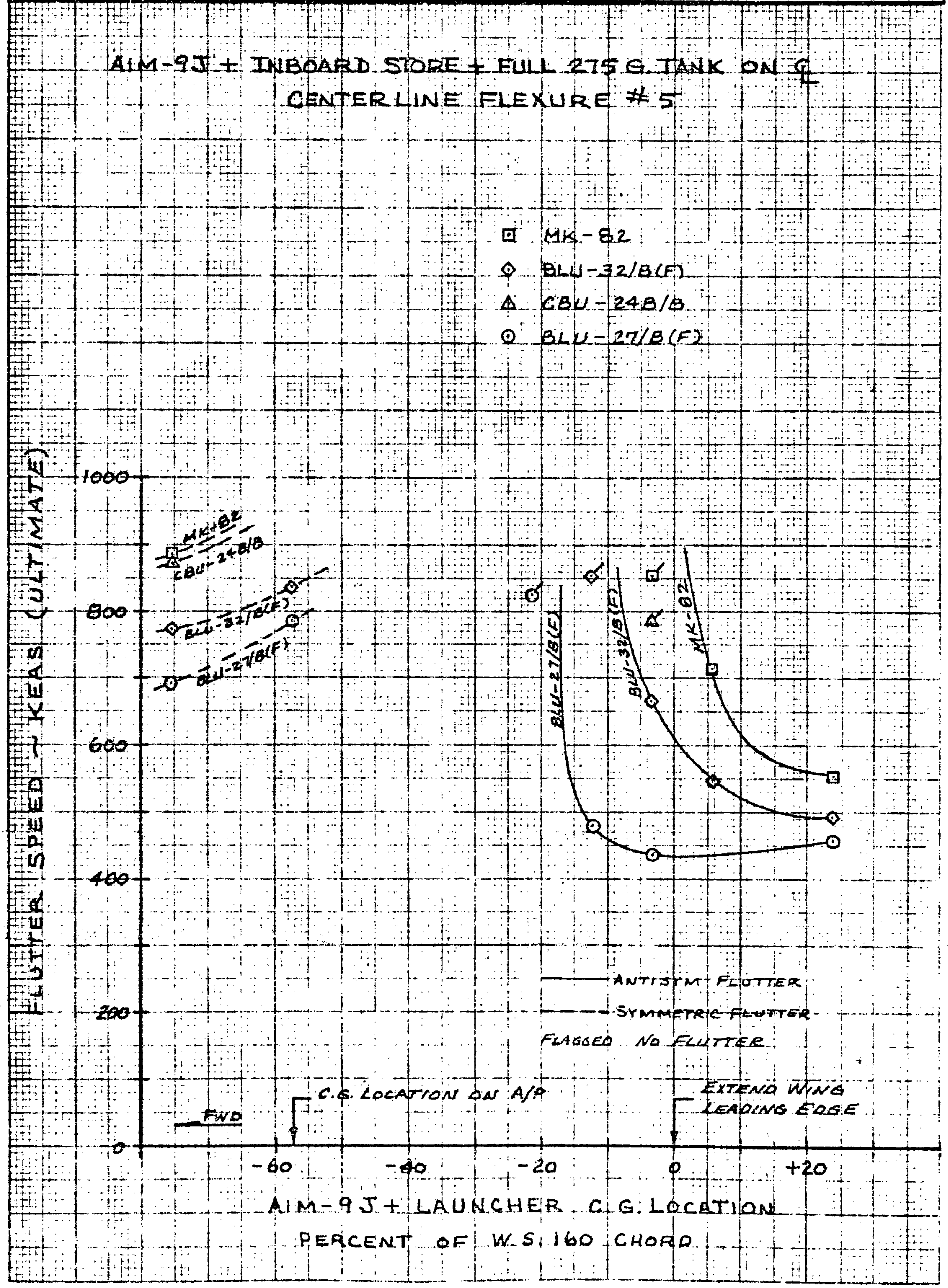
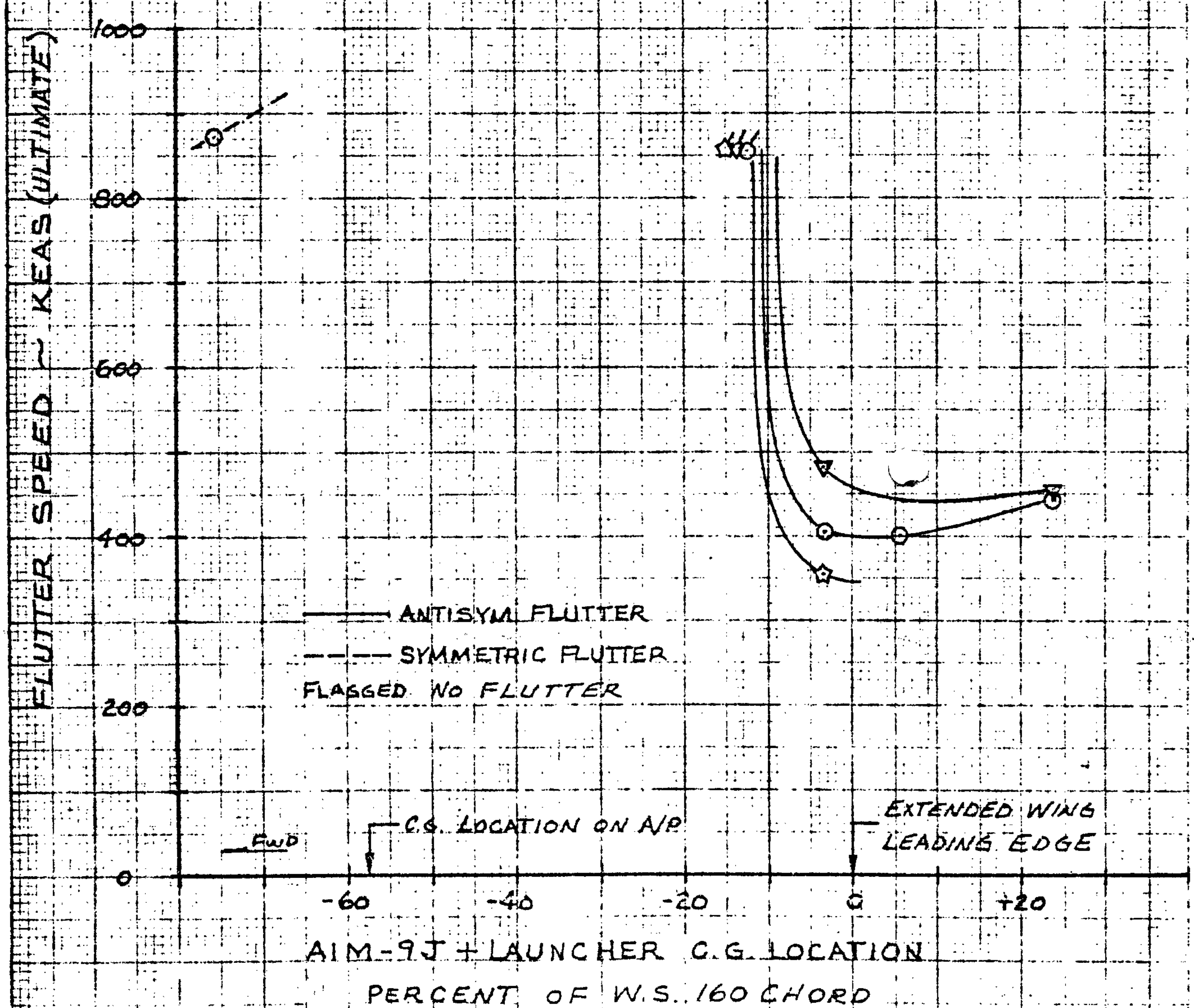
ENGINEER	Northrop Corporation Aircraft Division	PAGE 56
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 26	MODEL F-5E



AIM-9J + INBOARD MK-82 + MK-84 ON ℄
VARIOUS CENTERLINE FLEXURES

SYMBOL	FLEXURE	MK-84 CANTILEVERED FREQUENCIES (HZ)		
		ROLL	YAW	PITCH
▽	3	6.5	7.9	*
O	5	7.2	10.9	12.4
☆	RIGID	*	*	*

* RIGID



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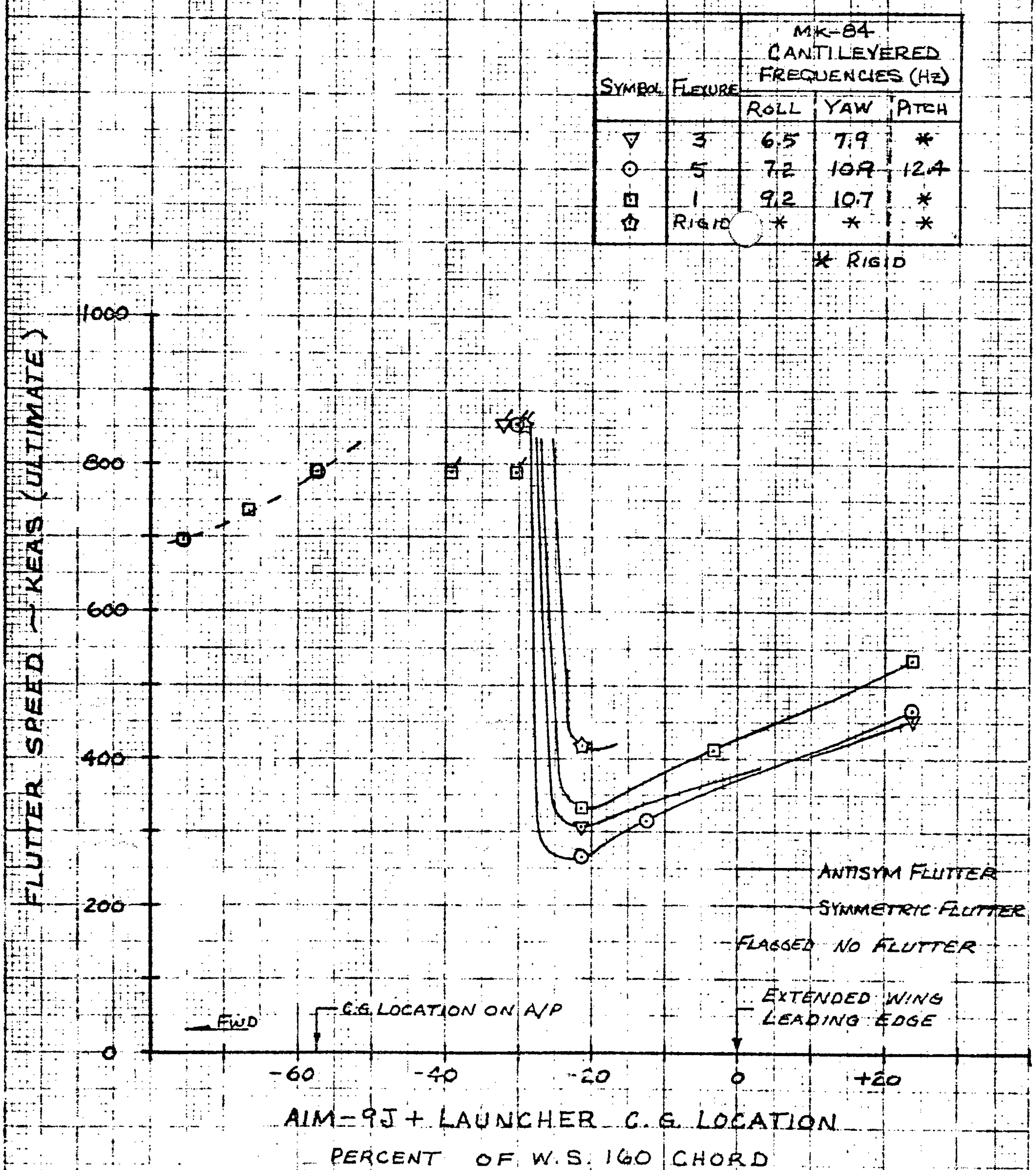
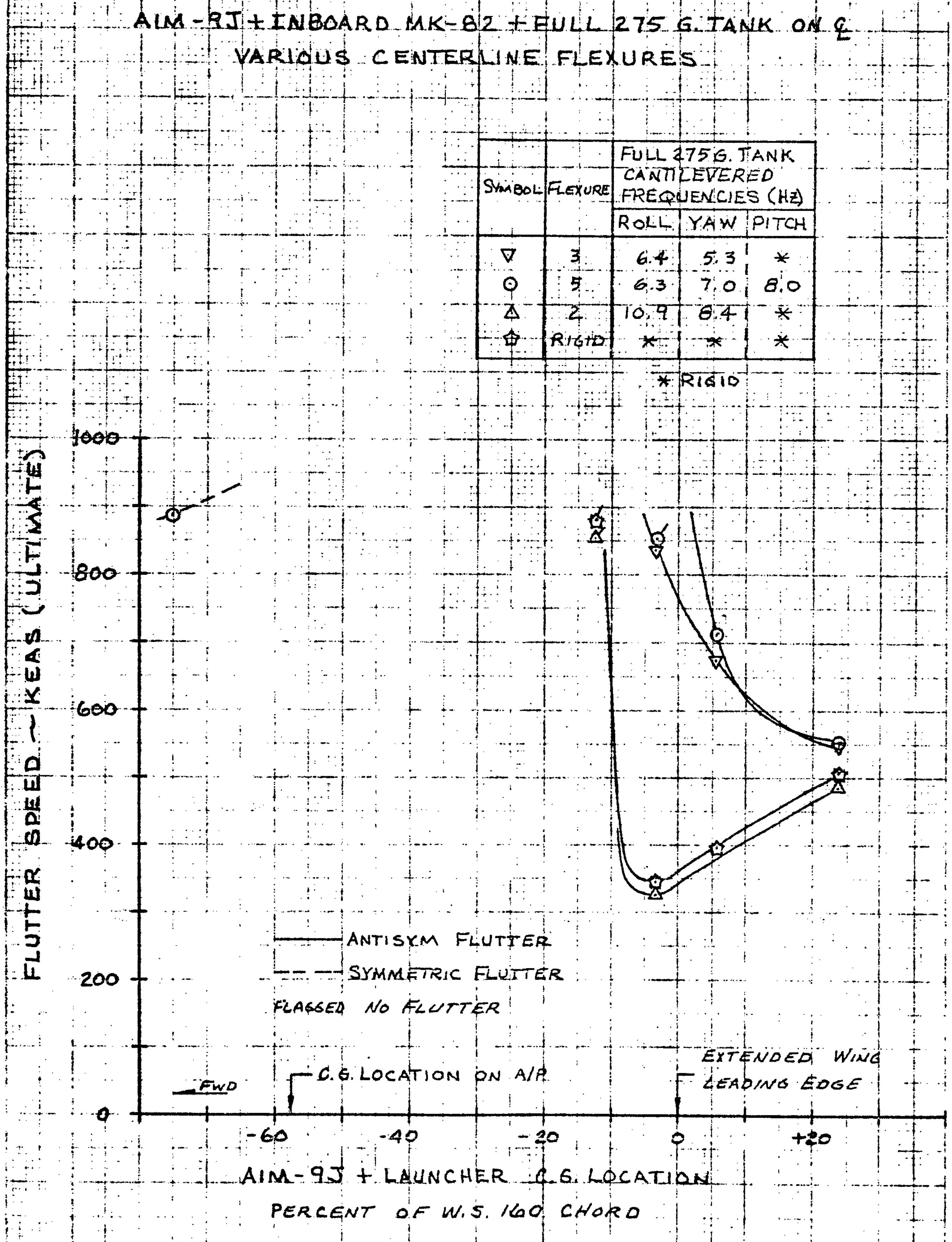
ENGINEER	Northrop Corporation Aircraft Division	PAGE 58
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 28	MODEL F-5E

AIM-9J + INBOARD BLU-27/B(F) + MK-84 ON ℄
VARIOUS CENTERLINE FLEXURES




AIM-9J + INBOARD MK-82 + FULL 275 G. TANK ON ℄
VARIOUS CENTERLINE FLEXURES
SYMBOL
FLEXURE
FULL 275 G. TANK CANTILEVERED FREQUENCIES (Hz)
ROLL
YAW
PITCH
▽ 3 6.4 5.3 *
○ 5 6.3 7.0 8.0
△ 2 10.9 8.4 *
⬠ RIGID * * *
* RIGID
FLUTTER SPEED ~ KEAS (ULTIMATE)
1000
800
600
400
200
0
ANTISYM FLUTTER
SYMMETRIC FLUTTER
FLAGGED NO FLUTTER
FWD
C.G. LOCATION ON A/P
EXTENDED WING LEADING EDGE
-60
-40
-20
0
+20
AIM-9J + LAUNCHER C.G. LOCATION
PERCENT OF W.S. 160 CHORD

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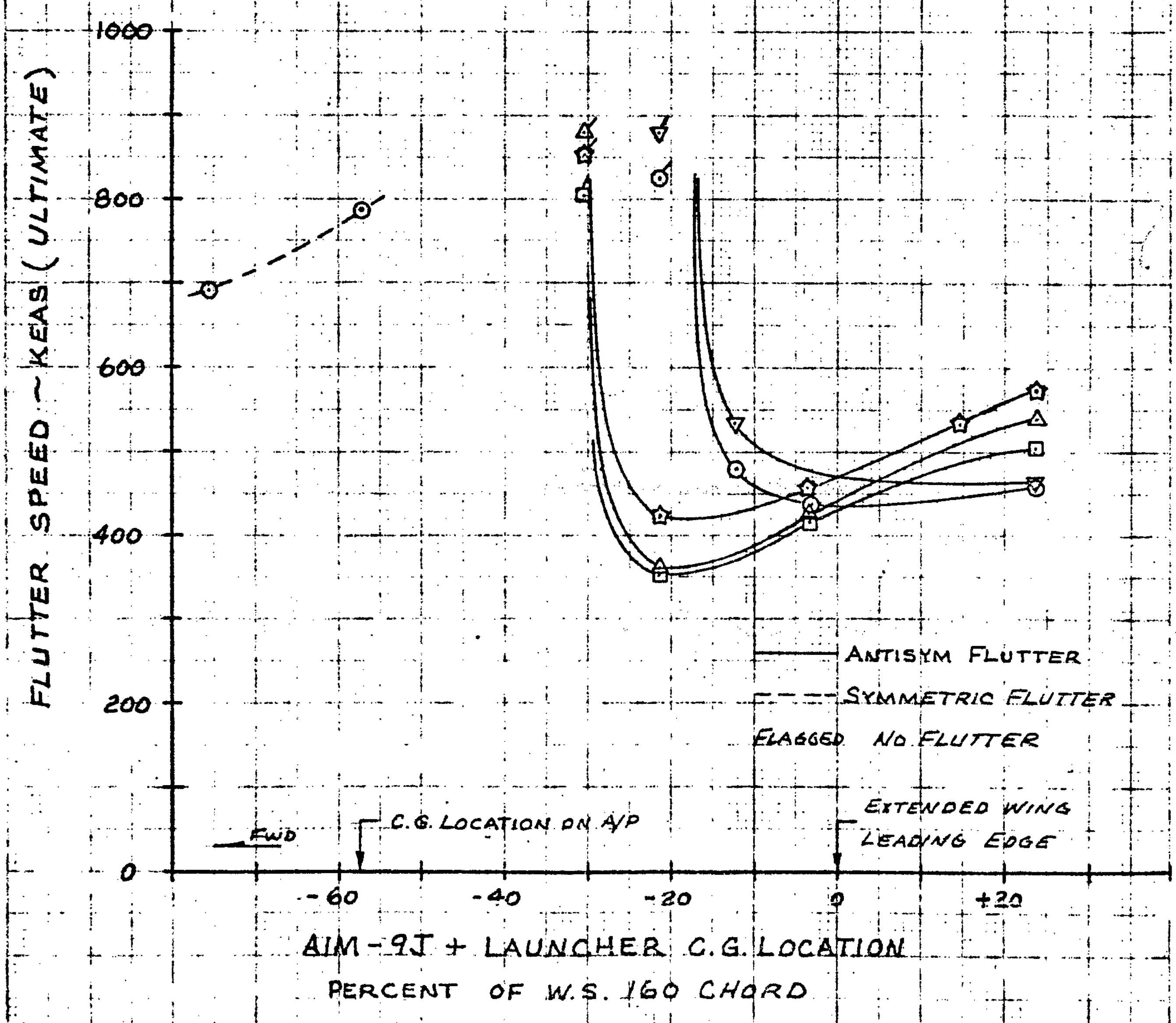
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 30	MODEL F-5E

AIM-9J + INBOARD BLU-27/B(F) + FULL 275 G. TANK ON ℄

VARIOUS CENTERLINE FLEXURES

SYMBOL	FLEXURE	FULL 275 G. TANK CANTILEVERED FREQUENCIES (Hz)		
		ROLL	YAW	PITCH
▽	3	6.4	5.3	*
⊙	5	6.3	7.0	8.0
⊡	1	8.6	6.8	*
△	2	10.9	8.4	*
☆	RIGID	*	*	*

* RIGID



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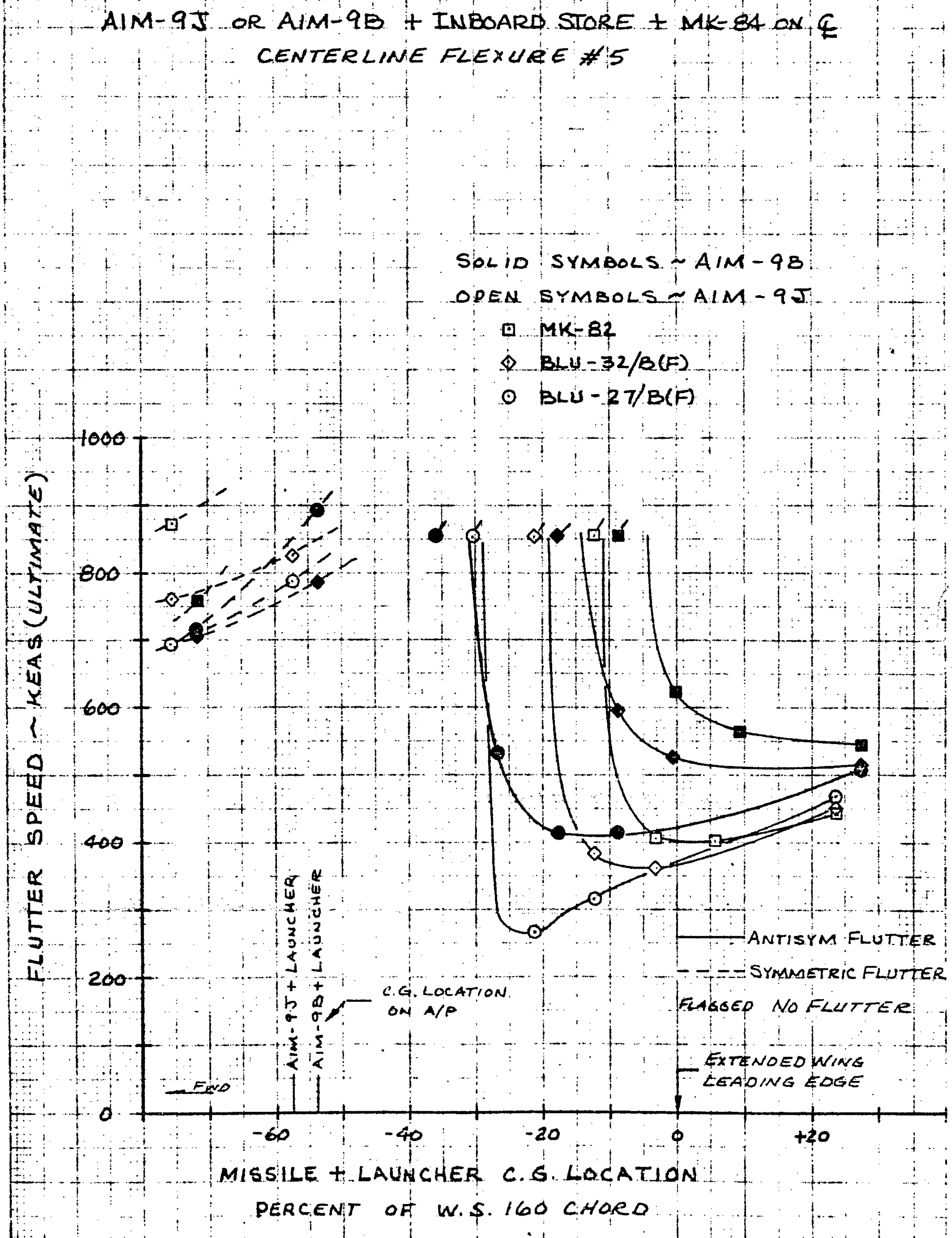
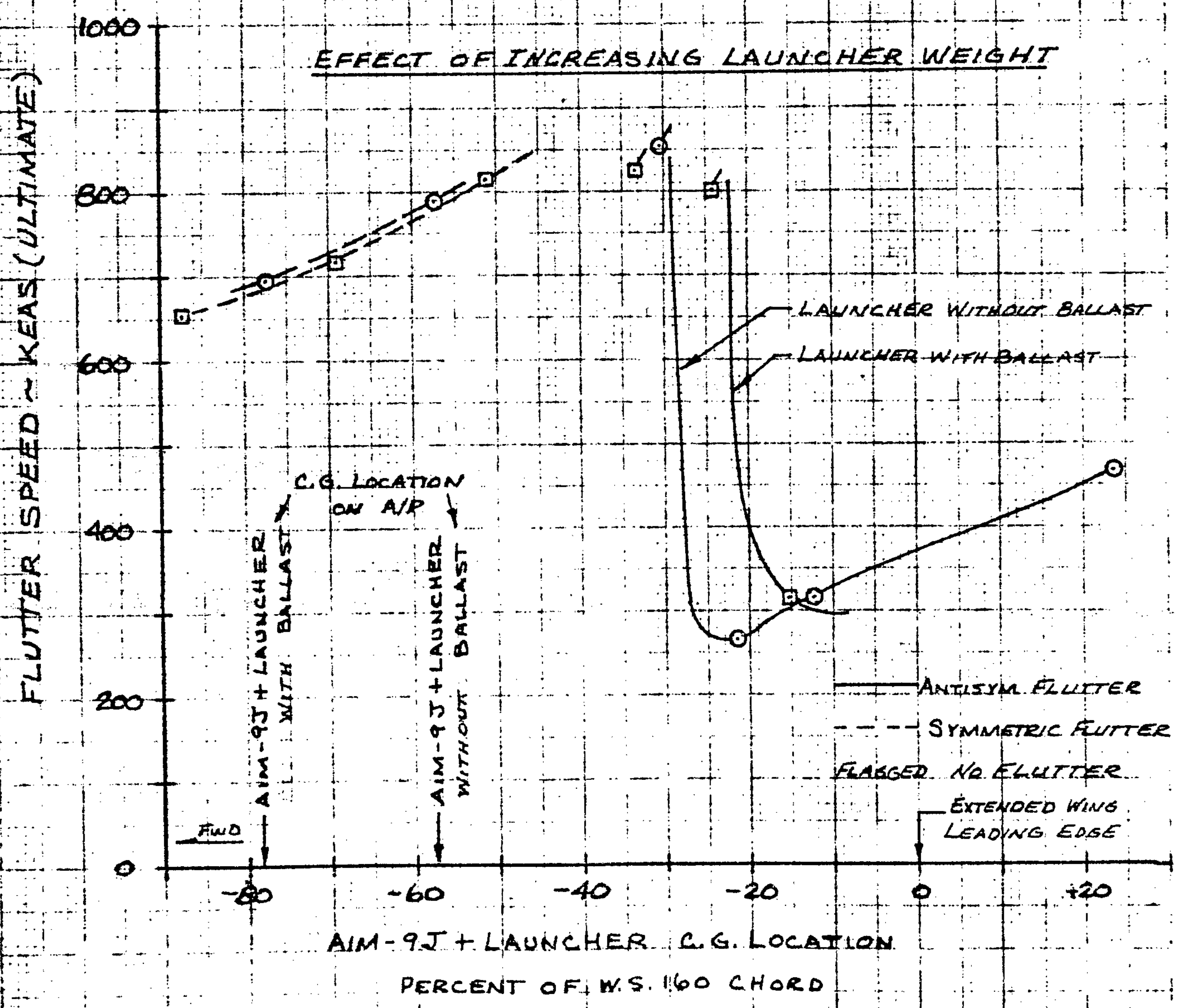
ENGINEER	Northrop Corporation Aircraft Division	PAGE 61
CHECKER		REPORT NO. NOR 71-162
DATE	Figure 31	MODEL F-5E



AIM-9J + INBOARD BLU-27/B(F) + ℄ MK-84
℄ FLEXURE No. 5

SYMBOL	LAUNCHER DATA		
	WT LB	C.G. LAU. STA	INERTIA LB IN²
○	49.2	48.80	26,289
□	97.2	33.98	48,156



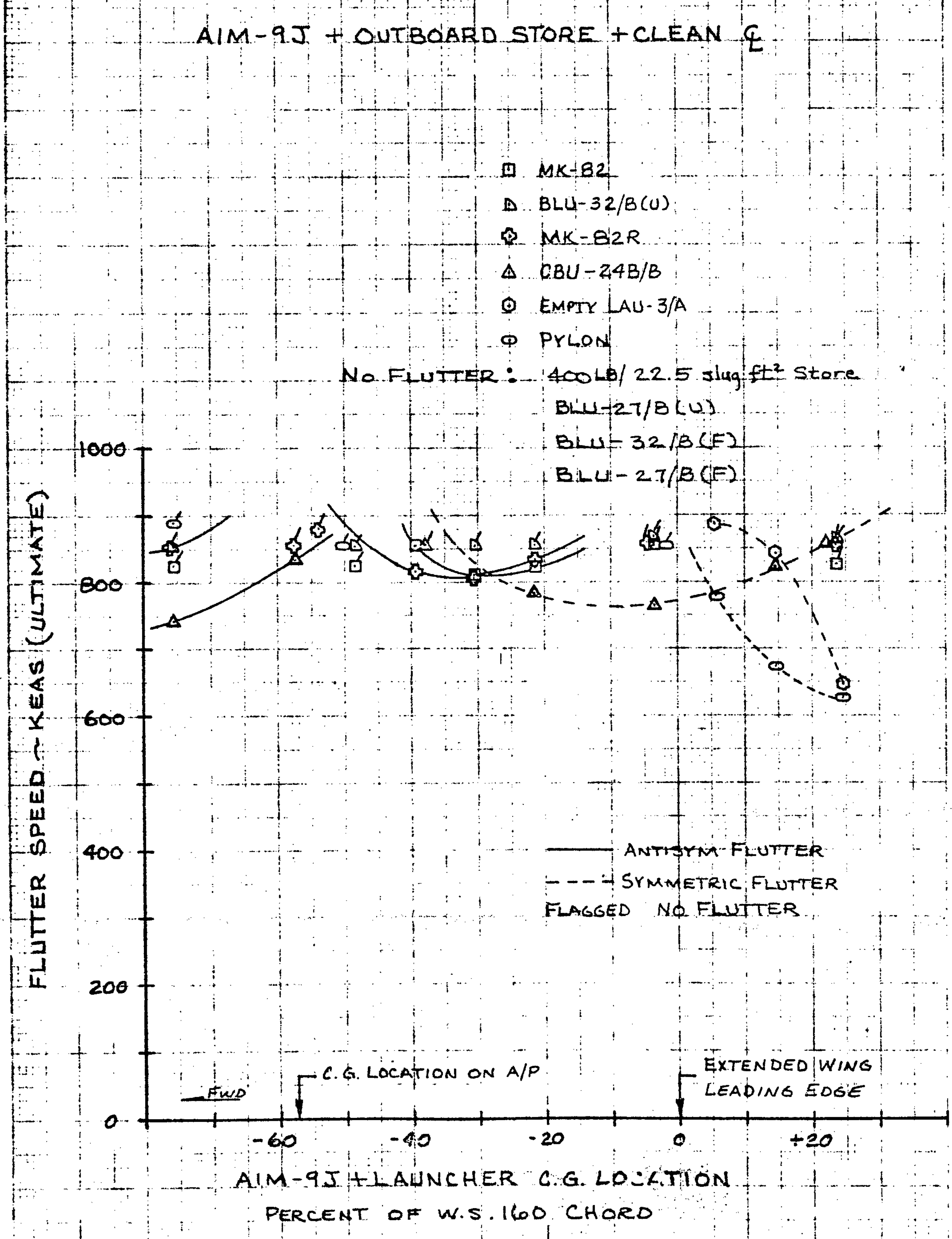

AIM-9J + OUTBOARD STORE + CLEAN ℄
MK-82
BLU-32/B(U)
MK-82R
CBU-24B/B
EMPTY LAU-3/A
PYLON
NO FLUTTER: 400 LB/ 22.5 slug ft² Store
BLU-27/B(U)
BLU-32/B(F)
BLU-27/B(F)
FLUTTER SPEED ~ KEAS (ULTIMATE)
1000
800
600
400
200
0
ANTISYM FLUTTER
SYMMETRIC FLUTTER
FLAGGED NO FLUTTER
FWD
C.G. LOCATION ON A/P
EXTENDED WING LEADING EDGE
-60
-40
-20
0
+20
AIM-9J + LAUNCHER C.G. LOCATION
PERCENT OF W.S. 160 CHORD

Figure 34

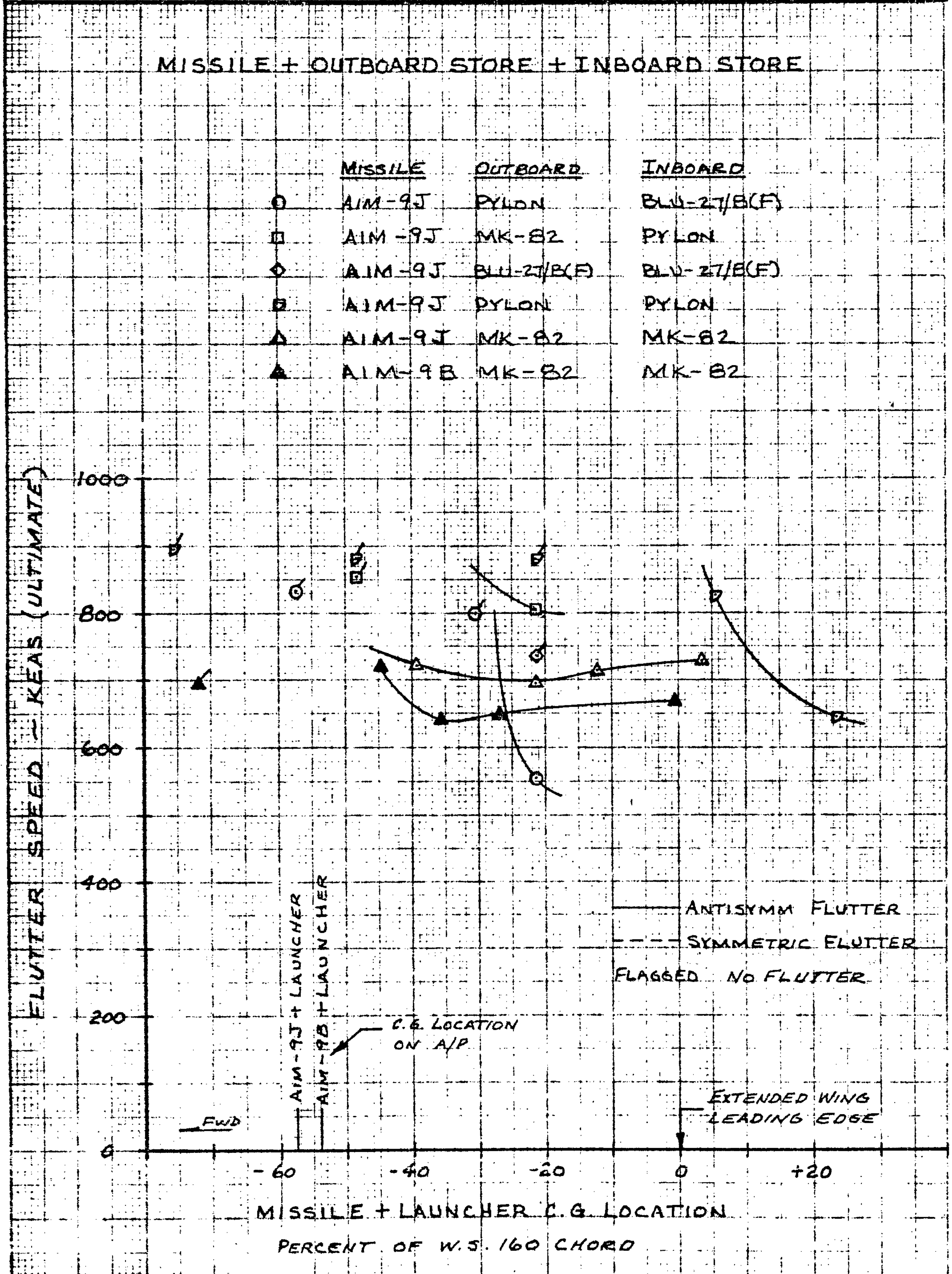

MISSILE + OUTBOARD STORE + INBOARD STORE
MISSILE OUTBOARD INBOARD
AIM-9J PYLON BLU-27/B(F)
AIM-9J MK-82 PYLON
AIM-9J BLU-27/B(F) BLU-27/B(F)
AIM-9J PYLON PYLON
AIM-9J MK-82 MK-82
AIM-9B MK-82 MK-82
FLUTTER SPEED ~ KEAS (ULTIMATE)
1000
800
600
400
200
0
ANTISYMM FLUTTER
SYMMETRIC FLUTTER
FLAGGED NO FLUTTER
AIM-9J + LAUNCHER
AIM-9B + LAUNCHER
C.G. LOCATION ON A/P
EXTENDED WING LEADING EDGE
FWD
-60
-40
-20
0
+20
MISSILE + LAUNCHER C.G. LOCATION
PERCENT OF W.S. 160 CHORD

TABLE 2A
F-5E FLUTTER MODEL, WIND TUNNEL TESTS, PHASE I

LAUNCHER TIP CONFIGURATIONS TESTED DURING PHASE I

*DOUBLE WING STORES				OUTB'D WING STORES				INBOARD WING STORES			
TIP	OUTB'D	INB'D	℄	TIP	OUTB'D	INB'D	℄	TIP	OUTB'D	INB'D	℄
Launcher	Clean	Clean		Launcher	BLU-27/B(F)			Launcher		BLU-27/B(F)	
	Clean	Clean	MK-84		MK-82					MK-82	
	Pylon	BLU-27/B(F)			CBU-24B/B					BLU-32/B(F)	
	MK-82	Pylon			BLU-32/B(F)					CBU-24B/B	
	MK-82	MK-82			MK-82R					BLU-27/B(U)	
	Pylon	Pylon			Empty LAU-3A					Pylon	
	Pylon	BLU-27/B(F)	Full 275		400 lb/22.5					BLU-27/B(F)	Full 275
					slug ft^2						
					Pylon					BLU-27/B(F)	75%F 275
										BLU-27/B(F)	50%F 275
										MK-82	Full 275
										MK-82	75%F 275
										MK-82	50%F 275
										BLU-32/B(F)	Full 275
										CBU-24B/B	Full 275
										BLU-27/B(F)	MK-84
										MK-82	MK-84
										BLU-32/B(F)	MK-84
										CBU-24B/B	MK-84
										200 lb/22.5	MK-84
										slug ft^2	
										BLU-27/B(F)	BLU-27/B(F)
										MK-82	BLU-27/B(F)

*Includes clean & pylon for convenience in tabulation and should not imply that any future restrictions for double stores would apply to clean or pylon.

TABLE 2B

F-5E FLUTTER MODEL, WIND TUNNEL TESTS, PHASE I

MISSILE TIP CONFIGURATIONS TESTED DURING PHASE I

*DOUBLE WING STORES				OUTB'D WING STORES				INB'D WING STORES			
TIP	OUTB'D	INB'D	℄	TIP	OUTB'D	INB'D	℄	TIP	OUTB'D	INB'D	℄
AIM-9J	Clean	Clean		AIM-9J	BLU-27/B(F)			AIM-9J		BLU-27/B(F)	
AIM-9J	Clean	Clean	MK-84		MK-82					MK-82	
	Pylon	BLU-27/B(F)			BLU-32/B(U)					BLU-32/B(F)	
	MK-82	Pylon			BLU-32/B(F)					CBU-24B/B	
	BLU-27/B(F)	BLU-27/B(F)			MK-82R					BLU-27/B(U)	
	Pylon	Pylon			BLU-27/B(U)					Pylon	
	MK-82	MK-82			CBU-24B/B					BLU-27/B(F)	MK-84
	Pylon	BLU-27/B(F)	MK-84		Empty LAU-3/A					BLU-27/B(F)	Full 275
AIM-9B					400 lb/22.5 slug ft^2					BLU-27/B(F)	75%F 275
										BLU-27/B(F)	50%F 275
AIM-9B			MK-84		Pylon						
AIM-9B	MK-82	MK-82								MK-82	Full 275
AIM-9B	MK-82	MK-82	MK-84							MK-82	75%F 275
										MK-82	50%F 275
										MK-82	MK-84
										BLU-32/B(F)	MK-84
										BLU-32/B(F)	Full 275
										CBU-24B/B	Full 275
								AIM-9B		BLU-27/B(F)	MK-84
										MK-82	MK-84
										BLU-32/B(F)	MK-84

*Includes clean & pylon for convenience in tabulation and should not imply that any future restrictions for double stores would apply to clean or pylon.

TABLE 3

Identification
of
Wing Tip Store C.G. Locations

Position No. **	TIP STORE C.G. LOCATION					
	Launcher		AIM-9J + Launcher		AIM-9B +Launcher	
	% Chord *	F.S.	% Chord *	F.S.	% Chord *	F.S.
12	-81.03	380.860	-75.48	382.355	-73.82	383.341
11	-72.02	383.286	-66.47	384.781	-62.81	385.767
10	-63.01	385.713	-57.46	387.208	-53.80	388.194
9	-54.00	388.140	-48.45	389.635	-44.79	390.621
8	-44.99	390.566	-39.44	392.061	-35.78	393.047
7	-35.98	392.993	-30.43	394.488	-26.77	395.474
6	-26.97	395.420	-21.42	396.915	-17.76	397.901
5	-17.96	397.846	-12.41	399.341	- 8.75	400.327
4	- 8.95	400.273	- 3.40	401.768	0.26	402.754
3	0.06	402.700	5.61	404.195	9.27	405.181
2	9.08	405.126	14.63	406.621	18.29	407.607
1	18.09	407.553	23.64	409.048	27.30	410.034

*% chord (26.931 inches) of extended wing at W.S. 160 relative to the leading edge (F.S. 402.683), + aft.

**Refers to the screw hole that is aligned with the forward mounting lug on the wing spar.

Note: On the F-5E, the tip stores are nominally located at Position # 10. Nominal locations of the c.g.'s are:

Launcher	F. S. 385.713
AIM-9J + Launcher	F. S. 387.208
AIM-9B + Launcher	F. S. 388.194

TABLE 4A

FUSELAGE DESIGN MASS AND INERTIA PROPERTIES, PHASE 1

Section	Fwd Boundary F.S.	Aft Boundary F.S.	Weight lb.	C.G. Location		$Ix_{c.g.}$ lb in^2	$Iy_{c.g.}$ lb in^2	$Iz_{c.g.}$ lb in^2
				FS	WL			
1	0	90.0	49.8	74.0	93.1	2,802	10,444	11,277
2	90.0	137.5	446.5	115.8	95.3	34,568	102,369	100,327
3[1]	137.5	194.0	1423	166.9	99.7	136,125	373,760	320,368
4	194.0	249.5	1212	228.7	109.2	325,236	611,728	517,152
5	249.5	284	550	267.8	110.9	186,550	190,368	160,512
6[2]	284	336.4	2526	309.3	108.8	266,192	253,696	269,600
7[2]	336.4	402.6	2250	366.8	107.1	414,074	-	-
8[2]	402.6	460	1919	431.9	103.8	332,864	293,888	338,432
9	460	canted	2199	499.9	101.4	569,344	1,540,610	1,802,240
10	canted	597	408	541.5	98.0	101,425	295,264	330,912
3[3]	137.5	194	1109	171.3	100.8	122,804	304,960	262,960
6[4]	284	336.4	613	308.2	103.4	242,713	229,264	268,576
7[4]	336.4	402.6	796	368.3	101.7	335,021	398,768	486,832
8[4]	402.6	460	822	433.6	98.6	294,299	251,008	333,984
9[5]	-	-	2359.5	501.1	104.1	918,519	-	-
10[6]	-	-	551.6	538.9	95.9	363,165	-	-

1 Ammunition included
2 Full fuel included, wing carry through structure included
3 Ammunition removed
4 Unusable fuel included
5 Sect 9 + vertical stabilizer
6 Sect 10 + horizontal stabilizer

TABLE 4B

FUSELAGE EXPERIMENTAL MASS AND INERTIA PROPERTIES, PHASE I

Section	Weight lb	C.G. Location F.S.	C.G. Location W.L.	$Ix_{c.g.}$ lb in^2
1	49.7	77.9	93.2	2,194
2	445.5	116.1	95.5	38,681
3[1]	1422.8	166.8	99.7	135,956
4[2]	1212.0	228.7	111.0	295,526
5	550.1	267.8	111.0	193,126
6	2527.7	309.1	108.4	452,140
7	2250.2	365.9	100.3	718,017
8	1918.6	431.9	103.8	316,334
9 + Vert. Stab.	2365.1	499.8	108.6	1,092,359
10 + Horiz. Stab.	603.2	536.4	95.5	438,609
4[3]	1852.0	224.7	108.1	362,557
4[4]	2492.0	220.7	106.5	412,787

[1] Including ammunition.

[2] Including the cone shaped inlet duct fairings.

[3] Including 640 lbs ballast at F.S. 217.16 for model stability.

[4] Including 1280 lbs ballast at F.S. 213.16 for model stability.

TABLE 5A

WING DESIGN MASS AND INERTIA PROPERTIES, PHASE 1

Section	Inboard W.S.	Outboard W.S.	Weight lbs.	C.G. F.S.	[1] Iycg lb. in^2
1	33.7 fwd 27.8 aft	43.7	263.38	380.230	232,743.
2	43.7	57.0	111.26	366.560	60,429.
3[2]	57.0	71.2	107.59	382.960	35,238.
4[2]	71.2	84.5	138.24	386.275	36,319.
5[3]	84.5	95.5	77.57	388.96	12,275.
6[3]	95.5	106.1	29.55	388.40	4,301.
7[3]	106.1	116.5	24.68	394.68	2,821.
8	116.5	128.2	38.38	397.63	4,597.
9	128.2	139.7	17.49	404.88	1,734.
10	139.7	151.1	32.23	409.80	1,392.

AILERON DESIGN MASS AND INERTIA PROPERTIES, PHASE 1

Inboard W.S.	Outboard W.S.	Wt lb	C.G.		Iycg lb in^2
			W. S.	F.S.	
84.5	116.5	16.25	97.46	420.52	611.5

1 Perpendicular to airstream
2 Landing gear of 257 lbs. at F.S. 390.9, W.S. 38.5 and

$Ix = 86,218$ lb in^2 distributed as follows:

strip 1	177.69 lbs. at F.S. 386.55
strip 3	39.655 lbs. at F. S. 393.05
strip 4	39.655 lbs. at F. S. 393.05

3 Aileron not included in these sections

TABLE 5B

WING EXPERIMENTAL MASS AND INERTIA PROPETIES, PHASE 1

Section	Left Wing			Right Wing		
	Weight lb	C.G. F.S.	[1] Iycg lb in^2	Weight lb.	C.G. F.S.	Iycg lb in^2
1[2]	263.526	382.983	240,372	264.274	382.501	236,636
2	111.809	367.014	62,975	111.654	366.594	62,284
3[2]	107.209	382.856	34,926	107.477	382.929	34,924
4[2]	136.844	385.984	34,901	136.674	385.912	34,518
5[3]	77.809	388.833	12,383	77.244	388.594	12,223
6[3]	29.510	388.446	4,188	29.651	388.411	4,145
7[3]	24.756	394.733	2,744	24.671	394.560	2,806
8	38.469	397.688	4,455	38.413	397.521	4,635
9	17.397	404.908	1,726	17.467	404.680	1,806
10	32.318	410.156	1,413	32.205	410.188	1,405

AILERON EXPERIMENTAL MASS AND INERTIA PROPERTIES, PHASE 1

Aileron	Wt lb	C.G.Location		Iycg lb. in^2
		WS	FS	
Left	16.43	97.68	420.47	612.1
Right	16.47	97.51	420.62	614.4

1 Perpendicular to airstream
2 Landing gear in "up" position distributed to these sections
3 Aileron not included in these sections.

TABLE 6

PYLON DESIGN MASS AND INERTIA DATA, PHASE I

Pylon	Weight	C.G. Location		Unbalance About Wing Spar	Inertia	
					At C.G.	About Wing Spar
	lb	F.S.	W.L.	lb in	lb in^2	lb in^2
W.S. 123 Pylon	124	376.9	82.9	3046.4	42,965	129,188
W.S. 93.5 Pylon	119	377.6	83.5	1291.0	20,542	44,184
C.L. Pylon	159	336.8	79.0	--	50,686	--

PYLON EXPERIMENTAL MASS AND INERTIA PROPERTIES, PHASE I

Pylon	Weight	C.G. Location		Unbalance About Wing Spar	Inertia	
					At C.G.	About Wing Spar
	lb	F.S.	W.L.	lb. in.	lb in^2	lb in^2
W.S. 123 Pylon, LH	134	-	-	2900	-	131,267
W.S. 123 Pylon, RH	135	-	-	2915	-	133,181
W.S. 93.5 Pylon, LH	118.7	-	-	1291	-	42,616
W.S. 93.5 Pylon, RH	118.5	-	-	1289	-	44,627
C.L. Pylon	158.5	336.7	-	-	-	-

TABLE 7A

EXTERNAL STORE DESIGN MASS AND INERTIA PROPERTIES, PHASE 1

Store	Weight lb	C.G.Location Inches aft of fwd lug	I c.g. (pitch/yaw) lb in^2	Slug-ft^2
BLU-27/B(F)	868	7.78	848,534	183.0
BLU-27/B(U)	853	6.78	774,346	167.0
BLU-32/B(F)	605	8.50	459,043	99.0*
BLU-32/B(U)	589	6.82	456,725	98.5
MK-82	531	7.50	196,137	42.3
MK-82R	560	8.50	243,432	52.5
LAU-3/A (Empty)	71	12.00	16,924	3.65
MK-84	1970	7.00	1,667,520	359.6
275 G. Tank (Dry)	184.4	21.17	593,900	128.1

WING TIP ARMAMENT DESIGN DATA, PHASE 1

Item	Weight lb	C.G.Location	Ic.g., (pitch) lb in^2	
Launcher	49.2	L.S. 48.8[1]	26,289	5.67
AIM-9J	172.5	M.S. 64.5[2]	250,387	54.0
AIM-9B	164.3	M.S. 55.8[3]	194,746	42.0
AIM-9E	168.5	M.S. 61.8[4]	224,421	48.4

* Revised data, received at end of test program, indicated BLU-32/B(F) inertia to be 110.0 slug-ft^2 (510048 lb-in^2)

1 Launcher-to-tip rib forward attach lug is located at L.S. 81.578 which coincides with F.S. 404.713.

2 The center missile-to-launcher hanger is located at M.S. 80.08 (F.S. 403.215)

3 The center missile-to-launcher hanger is located at M.S. 70.077 (F.S. 403.215)

4 The center missile-to-launcher hanger is located at M.S. 76.504 (F.S. 403.215) This store was not tested during Phase 1.

5 The above design data is based on NOR 71-83 "External Stores Data for F-5E Aircraft."

TABLE 7B

EXTERNAL STORE EXPERIMENTAL MASS AND INERTIA PROPERTIES, PHASE 1

Store[1]		Weight lb	C.G. Location Inches aft of fwd lug	Inertia (pitch/yaw) lb in^2
BLU-27/B(F)	#1	868	7.88	837,149
	#2	867	7.99	844,175
BLU-27/B(U)	#1	853	6.72	764,822
	#2	853	6.80	771,977
BLU-32/B(F)	#1	605	8.60	521,252
	#2	602	8.40	521,141
BLU-32/B(U)	#1	588	6.84	457,593
	#2	586	6.80	453,785
MK-82	#1	529	7.88	198,989
	#2	530	7.68	201,649
MK-82R	#1	561	9.72	245,020
	#2	561	9.60	246,943
LAU-3/A	#1	71	12.00	17,056
(Empty)	#2	71	12.00	17,031
	#3	71	12.00	16,953
	#4	71	11.92	17,070
MK-84		1970	7.20	1,693,549
275G.Tank (Dry)		187	21.20	607,433

WING TIP ARMAMENT EXPERIMENTAL DATA, PHASE 1

Item	Weight lb	C.G. Location	I C.G.(Pitch) lb in^2
Launcher, LH	48.3	L.S. 48.72	25,467
Launcher, RH	48.3	L.S. 48.80	25,323
AIM-9J, LH	169.6	M.S. 64.58	243,343
AIM-9J, RH	169.9	M.S. 64.58	242,852
AIM-9B, LH	163.4	M.S. 55.84	192,183
AIM-9B, RH	163.5	M.S. 56.00	190,932

1 Odd numbered stores were left hand and even numbered stores were right hand.

TABLE 8

VARIABLE MASS ARMAMENT STORES

Store** Represented	Serial No.	Dia. in	Length in	Experimental Data		
				Weight lb	C.G. Location Inches aft of fwd lug	Inertia (pitch/yaw) lb in^2
*868/183	3	17	116	869	7.00	875,991
	4	17	116	878	7.04	876,132
*531/42.3	1	10	96	531	7.60	200,178
	2	10	96	531	7.52	200,337
*823/60.4	1	17	116	845	4.60	292,185
	2	17	116	844	5.60	276,061
200/22.5		10	96	200	7.00	104,328
400/22.5	1	17	116	388	7.00	104,775
	2	17	116	388	6.88	104,380
	3	17	116	384	6.92	103,892
	4	17	116	388	6.96	103,212

**Weight (lbs)/Pitch Inertia (slug-ft^2)

*These variable mass store ballast conditions are representative of the following stores; BLU-27B(F), MK-82, CBU-24B/B.

TABLE 9

W.S. 123 Pylon Spar Stiffness

*E.A. Coordinates		Design			Calculated from Spar Dimensions		
X inches fwd	Z inches below	EI_{pitch} lb in^2 $X10^{-6}$	$EI_{lateral}$ lb in^2 $X10^{-6}$	GJ lb in^2 $X-10^6$	EI_{pitch} lb in^2 $X10^{-6}$	$EI_{lateral}$ lb in^2 $X10^{-6}$	GJ lb in^2 $X10^{-6}$
46.7	8.1	288.7	117.7	21.5	288.7	118.8	56.9
23.4	5.7	707.1	243.4	86.4	707.1	244.7	229.2
23.4	9.0	707.1	243.4	322.	6032.4	243.4	850.4
19.7	8.9	907.0	298.9	342.6	1998.1	298.9	904.8
19.7	11.5	907.0	298.9	156.7	907.0	300.0	413.9
13.1	10.6	1146.2	279.9	197.3	1114.2	281.3	519.4
6.3	5.5	1421.0	295.6	253.0	1421.0	297.0	668.6
3.4	3.3	595.3	236.8	145.7	595.3	237.8	386.9

*Ref. 35% chord at wing reference plane which is at Fus. Sta. 398.268 W.L.100

TABLE 10

W.S. 93.5 Pylon

Flexure No.	Frequency with Blu-27/B(F)		
	Pitch cps	Yaw cps	Roll cps
9301 L.H.	15.2	13.5	32.7
9301 R.H.	15.3	13.6	34.7
9302 L.H.	11.5	10.1	27.7
9302 R.H.	11.6	10.1	27.9
9303 L.H.	19.1	15.7	30.0
9303 R.H.	19.1	15.6	33.2

W.S. 123 Pylon

Flexure No.	Frequency with BLU-27/B(F)		
	Pitch cps	Yaw cps	Yaw/Roll cps
LH 123 01	11.27	7.44	16.20
RH 123 01	11.28	7.49	16.24
LH 123 02	11.00	7.37	14.73
RH 123 02	10.92	7.36	15.17
LH 123 03	11.48	7.35	16.91
RH 123 03	11.68	7.71	17.61

Centerline Pylon

Flexure No.	Frequency with MK-84			Frequency w/full 275 G.Tank		
	Pitch cps	Yaw cps	Roll cps	Pitch cps	Yaw cps	Roll cps
0001	66.1	10.7	9.2	-	6.8	8.6
0002	72.8	13.3	11.7	-	8.4	10.9
0003	57.6	7.9	6.5	-	5.3	6.4
0004	14.0	11.6	30.3	8.7	8.7	-
0005	12.4	10.9	7.2	8.0	7.0	6.3

Centerline Flexure No. 0005 Frequencies

Store	Frequency		
	Pitch cps	Yaw cps	Roll cps
Full 275G. Tank	8.0	7.0	6.3
MK-84	12.4	10.9	7.2
BLU-27/B(F)	17.8	15.4	10.1
BLU-32/B(F)	22.5	19.3	14.0
MK-82R	31.7	28.8	18.3

TABLE 11 (a)
FLUTTER MODEL RESONANT FREQUENCIES

Config. No.	Wing Tip Store	Outb'd Wing Store	Inb'd Wing Store	Fuselage ℄ Store	Mode Description	Frequencies Sym (Hz)	Frequencies A-S (Hz)
1	Launcher Rail				First Wing Bending	7.20	10.97
					Fuselage Bending	9.67	
					Vertical Stab. Bending		15.23
					First Wing Torsion	16.76	16.77
					Horizontal Stab. Bending		20.79
					Coupled Horiz.Stab./Fus.Bend.	21.45	
					Coupled Wing/Fuselage	23.55	
					Coupled Fwd.Fus.Tors./Aft Fus.Bend.		23.84
					Coupled Wing/Fuselage	27.03	
					Higher Wing Mode		31.55
2	Launcher Rail		BLU27B(F)		First Wing Bending	5.47	10.25
					First Wing Torsion	7.45	7.23
					Fuselage Bending	9.53	
					Coupled Wing/Store		11.19
					Store Yaw-Insignificant Coupling	12.72	12.87
					Vertical Stabilizer Bending		14.63
					Coupled Wing/Fuselage	14.96	
					Higher Coupled Wing/Fuselage	17.97	
					Aft Fuselage Bending		19.44
					Coupled Wing/Horiz.Stab.Bending		20.48
3	Launcher Rail	BLU27B(F)	BLU27B(F)		First Wing Bending	3.36	6.00
					First Wing Torsion	4.53	4.19
					Coupled Stores	8.81	8.33
					Coupled Fus.Bend./Wing/Stores	9.48	10.31
					Coupled Fus./Wing/Stores	11.31	12.35
					Inboard Store Yaw	12.75	12.80
					Coupled Vert.Stab./Wing Stores		15.03
					Higher Wing/Store Fuselage	18.23	
					Higher Torsion		18.63

TABLE 11 (a)
FLUTTER MODEL RESONANT FREQUENCIES

Config. No.	Wing Tip Store	Outb'd Wing Store	Inb'd Wing Store	Fuselage ℄ Store	Mode Description	Frequencies Sym (Hz)	Frequencies A-S (Hz)
4	Launcher Rail	BLU27B(F)			First Wing Bending	3.44	6.17
					First Wing Torsion	4.67	4.32
					Outboard Store Yaw	6.93	
					Coupled Wing/Store Yaw/Fus. Roll		9.45
					Coupled Wing/Store Yaw/Fus.Bending	11.81	
					Outboard Store Yaw		12.52
					Vertical Fin Bending		16.43
					Fus. Lateral/Wing Fore-Aft Bending		16.76
					Outboard Wing Torsion	16.96	18.65
5	AIM-9J				First Wing Bending	4.36	8.33
					First Wing Torsion	6.77	6.17
					Fuselage Bending	9.44	11.35
					Coupled Vert. Stab.Bending/Wing		14.93
					Fuselage Bending		17.48
					Higher Wing Mode	18.53	
					Horiz. Stabilizer Bending	20.72	20.51
					Wing Fore-Aft Bending	21.85	
					Coupled Wing/Fuselage		22.11
					Higher Wing Mode	27.73	
6	AIM-9J		BLU27B(F)		First Wing Bending	4.09	9.47
					First Wing Torsion	6.15	5.91
					Coupled Wing/Fuselage	9.53	10.47
					Store Yaw/Fus. Bending	12.91	
					Vert.Stab.Bending/Store Yaw		13.99
					Coupled Wing/Fus./Vert. Stab.		18.52
					Horiz. Stab. Bending	20.97	20.37
					Wing Fore-Aft/Fus. Lateral		21.73

TABLE 11 (a)
FLUTTER MODEL RESONANT FREQUENCIES

Config. No.	Wing Tip Store	Outb'd Wing Store	Inb'd Wing Store	Fuselage ℄ Store	Mode Description	Frequencies Sym (Hz)	A-S (Hz)
7	AIM-9J	BLU27B(F)			First Wing Bending	3.11	5.77
					First Wing Torsion	4.23	4.17
					Wing Bending/Store Yaw	6.79	7.36
					Wing/Store Pitch/Aft Fus.Bending	7.55	
					Coupled Wing/Store Yaw		9.21
					Coupled Fuselage/Wing/Store	9.48	
					Fus. Lat/Wing Fore-Aft Bending		10.55
					Wing/Store Yaw/Fus. Bending	11.40	
					Weak Fus./Wing/Store Mode		12.27
					Whole Airplane		15.72
					Wing Store Roll	16.89	

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE AND LAUNCHER + CLEAN WING

		Flutter Characteristics			Wing Tip		W. S. 123			W.S. 93.5			Fuselage ℄				Symm Freqs at V=0 cps	
Run No.	Max. Speed Tested kts	Flutter Speed kts	Freq. cps	Type	Store	C.G. % Chord	Store	Flex No.	Pylon Loc.	Store	Flex No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full	Airplane Attitude	Bend.	Tors.
2	880	--			Launcher	-63.0										Level	7.20	
228	880	--				-36.0											7.11	17.33
227	880	--				- 9.0											7.11	19.37
226	896	--				+18.1											7.08	20.89
459	880				Launcher	-54.0							MK-84	5	-	-	7.12	16.51
460	880					-18.0											7.08	18.57
234	907	907	9.28	Sym	AIM-9J	-75.5											4.16	6.67
233	853					-57.5											4.33	6.67
232	860					-30.4											4.41	6.67
231	880					-12.4											4.44	6.81
230	667	667	5.87	Sym		+ 5.6											4.41	6.85
229	552	552	5.97	Sym		+23.6											4.39	6.93
471	845	845	6.27	Sym	AIM-9B	+ 0.3											4.49	7.60
469	720	720	6.27	Sym		+ 9.3											4.44	7.59
470	611	611	6.35	Sym		+27.3											4.44	7.81
MISSILE + CLEAN WING AND ℄ STORE																		
465	907				AIM-9J	-75.5							MK-84	5			4.20	6.67
462	980					-12.4											4.44	6.85
463	448	448	6.52	A.S.		- 3.4											4.39	6.75
461	416	416	6.55	A.S.		+ 5.6											4.39	6.89
464	453	453	6.67	A.S.		+23.6											4.36	7.03
466	853				AIM-9B	- 8.8							MK-84	5			4.51	7.56
467	653	653	6.80	A.S.		+ 0.3											4.44	7.53
468	585	585	6.79	A.S.		+ 9.3											4.48	7.61

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

LAUNCHER + INBOARD STORE

Table 13A

Run No.	Max. Speed Tested (kts)	Flutter Characteristics: Flutter Speed (kts)	Flutter Characteristics: Freq. (cps)	Flutter Characteristics: Type	Wing Tip: Store	Wing Tip: C.G. % Chord	W. S. 123: Store	W. S. 123: Flex No.	W. S. 123: Pylon Loc.	W. S. 93.5: Store	W. S. 93.5: Flex No.	W. S. 93.5: Pylon Loc.	Fuselage ℄: Store	Fuselage ℄: Flex No.	Fuselage ℄: Store Fuel Content % Full	Airplane Attitude	Symm Freqs at V=0 cps: Bend.	Symm Freqs at V=0 cps: Tors.
131	880	--			Launcher	-81.0				BLU-27/B(F)	#1	N				Level	5.44	7.47
39	853	--				-54.0											5.41	7.43
40	853	--				-27.0											5.41	7.43
128	880	--				-18.0											5.48	7.41
129	880	--				- 9.0											5.45	7.41
127	813	813	21.3			+0.06											5.44	7.43
130	821	821	21.3	A.S.		+ 9.0											5.47	7.47
126	880	880	22.2	A.S.		+18.0											5.44	7.47
83	651	651	10.5	A.S.	Launcher	-81.0				MK-82	#1	N				Level	6.04	-
87	680	680	10.7	A.S.		-63.0											6.05	12.0
88	760	760	10.7	A.S.		-45.0											6.08	12.0
84	801	801	12.0	A.S.		-27.0											6.00	12.1
89	715	715	12.0	A.S.		-18.0											6.00	12.0
86	667	667	12.0	A.S.		+0.06											6.00	12.0
85	661	661	12.0	A.S.		+18.1											6.00	12.0
102	763	763	9.6	A.S.	Launcher	-81.0				BLU-32/B(f)	#1	N				Level	5.87	8.89
103	827	827	9.6	A.S.		-63.0											5.87	9.00
104	869	869	9.7	--		-45.0											5.87	8.89
105	880	---	---	--		+18.0											5.77	8.89
101	885	---	---	--		+18.1											5.77	8.89
120	741	741	9.4	A.S.	Launcher	-81.0				CBU-24B/B	#1	N				Level	5.52	9.11
121	805	789	9.6	A.S.		-63.0											5.77	9.33
122	875	837	9.8	A.S.		-45.0											5.56	9.08
123	896	880	9.6	A.S.		-27.0											5.56	8.89
124	880	--				- 9.0											5.49	8.89
125	880	--				+18.1											5.51	8.89
243	864	--			Launcher	-54.0				BLU-27/B(U)	#1	N				Level	5.41	7.48
242	816	816	21.1	A.S.		+0.06											5.41	7.53
98	880	-	-	-	Launcher	-81.0				Pylon	#1	N				Level	6.93	14.85
97	880	-	-	-		-54.0											6.97	16.25
99	880	-	-	-		-18.0											7.00	17.33
100	880	-	-	-		+18.1											6.85	20.44

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

LAUNCHER + INBOARD STORE + ℄ 275 G. TANK

Run No.	Max. Speed Tested (kts)	Flutter Characteristics: Flutter Speed (kts)	Flutter Characteristics: Freq. (cps)	Flutter Characteristics: Type	Wing Tip: Store	Wing Tip: C.G. % Chord	W. S. 123: Store	W. S. 123: Flex. No.	W. S. 123: Pylon Loc.	W.S. 93.5: Store	W.S. 93.5: Flex No.	W.S. 93.5: Pylon Loc.	Fuselage ℄: Store	Fuselage ℄: Flex No.	Fuselage ℄: Store Fuel Content % Full	Airplane Attitude	Symm Freqs at V=0 cps: Bend.	Symm Freqs at V=0 cps: Tors.
30	593	593	7.61	A.S.	Launcher	-81.0				BLU-27/B(F)	1	N	275 G. Tank	1	Full	Level	5.45	7.40
33	560	560	7.57	A.S.		-54.0											5.43	7.43
31	563	563	7.48	A.S.		-27.0											5.36	7.32
32	587	587	7.48	A.S.		+18.1											5.43	7.44
247	880	-	-	-	Launcher	-81.0				BLU-27/B(F)	1	N	275 G. Tank	5	Full	Level	5.41	7.27
244	827	-	-	-		-54.0											5.41	7.23
245	827	-	-	-		-27.0											5.44	7.40
249	880	-	-	-		- 9.0											5.36	7.27
248	788	788	21.2	A.S.		+0.06											5.44	7.27
246	877	877	21.5	A.S.		+18.1											5.43	7.33
289	880	-	-	-	Launcher	-81.0				BLU-27/B(F)	1	N	275 G. Tank	Rigid	Full	Level	5.41	7.32
288	880	-	-	-		-54.0											5.44	7.33
287	880	-	-	-		-27.0											5.41	7.37
290	857	857	21.3	A.S.		+0.06											5.43	7.43
309	880	-	-	-	Launcher	-81.0				BLU-27/B(F)	1	N	275 G. Tank	2	Full	Level	5.42	7.32
307	853	-	-	-		-45.0											5.45	7.37
308	853	-	-	-		-27.0											5.44	7.33
310	791	791	21.2	A.S.		+0.06											5.36	7.27
329	853	-	-	-	Launcher	-54.0				BLU-27/B(F)	1	N	275 G. Tank	3	Full	Level	5.39	7.23
328	853	-	-	-		-27.0											5.36	7.27
258	692	692	10.4	A.S.	Launcher	-81.0				MK-82	1	N	275 G. Tank	5	Full	Level	5.97	11.56
260	803	803	10.6	A.S.		-45.0											5.97	12.10
256	828	828	11.9	A.S.		-27.0											5.96	11.96
259	686	688	12.0	A.S.		-18.0											5.97	12.09
257	633	633	12.1	A.S.		+18.1											6.00	12.00
295	755	755	10.1	A.S.	Launcher	-81.0				MK-82	1	N	275 G. Tank	Rigid	Full	Level	5.97	11.68
296	589	589	10.3	A.S.		-63.0											5.97	11.81
294	555	555	10.3	A.S.		-45.0											6.00	12.00
293	557	557	10.2	A.S.		-27.0											6.00	11.96
292	563	563	10.3	A.S.		-18.0											6.00	12.00
291	587	587	10.3	A.S.		-0.06											5.91	11.96
303	563	563	10.2	A.S.	Launcher	-27.0				MK-82 (Variable Mass Store Check)	1	H	275 G. Tank	Rigid	Full	Level	6.00	12.44

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

LAUNCHER + INBOARD STORE + ℄ 275 G. TANK (CONT'D)

Run No.	Max. Speed Tested (kts)	Flutter Characteristics: Flutter Speed (kts)	Flutter Characteristics: Freq. (cps)	Flutter Characteristics: Type	Wing Tip: Store	Wing Tip: C.G. % Chord	W. S. 123: Store	W. S. 123: Flex No.	W. S. 123: Pylon Loc.	W. S. 93.5: Store	W. S. 93.5: Flex No.	W. S. 93.5: Pylon Loc.	Fuselage ℄: Store	Fuselage ℄: Flex No.	Fuselage ℄: Store Fuel Content % Full	Airplane Attitude	Symm Freqs at V=0 cps: Bend	Symm Freqs at V=0 cps: Tors.
305	880	-	-	-	Launcher	-81.0				MK-82	1	N	275 G. Tank	2	Full	Level	5.91	11.68
304	880	-	-	-		-27.0											6.00	12.00
306	880	-	-	-		+0.06											6.00	12.00
320	683	683	10.4	A.S.	Launcher	-81.0				MK-82	1	N	275 G. Tank	3	Full	Level	5.97	11.68
318	793	793	10.7	A.S.		-45.0											6.00	12.00
319	691	691	11.7	A.S.		-18.0											5.97	11.96
321	639	639	12.0	A.S.		+18.1											6.00	12.00
407	853	-	-	-	Launcher	-81.0				BLU-27/B(F)	1	N	275 G. Tank	5	75%	Level	5.36	7.40
408	853	-	-	-		-54.0											5.44	7.33
406	853	-	-	-		-18.0											5.44	7.33
390	853	-	-	-	Launcher	-81.0				BLU-27/B(F)	1	N	275 G. Tank	5	50%	Level	5.39	7.08
389	853	-	-	-		-54.0											5.36	7.47
388	853	-	-	-		-18.0											5.36	7.32
396	745	745	10.7	A.S.	Launcher	-81.0				MK-82	1	N	275 G. Tank	5	75%	Level	6.00	11.56
399	821	821	10.7	A.S.		-45.0											6.00	11.87
397	885	885	11.6	A.S.		-18.0											5.97	12.09
400	709	709	12.1	A.S.		- 9.0											5.97	12.24
398	672	672	12.3	A.S.		+18.1											5.97	11.81
378	692	692	10.4	A.S.	Launcher	-81.0				MK-82	1	N	275 G. Tank	5	50%	Level	5.95	11.56
379	685	685	10.5	A.S.		-45.0											6.04	12.00
377	751	751	10.7	A.S.		-18.0											6.00	12.00
376	856	856	11.6	A.S.		+18.1											5.95	11.81
271	861	861	9.6	A.S.	Launcher	-81.0				BLU-32/B(F)	1	N	275 G. Tank	5	Full	Level	5.87	9.20
272	893					-54.0											5.84	8.93
273	880					-18.0											5.84	8.76
274	892	892	7.88	Sym		+18.1											5.77	9.11
278	825	825	9.37	A.S.	Launcher	-81.0				CBU-24B/B	1	N	275 G. Tank	5	Full	Level	5.47	8.81
277	884	884	9.45	A.S.		-54.0											5.48	8.67
276	891					-18.0											5.48	8.60
275	853					+18.1											5.48	8.53

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

LAUNCHER + INBOARD STORE + ℄ MK-84

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W.S. 123			W.S. 93.5			Fuselage ℄			Airplane Attitude	Symm Freqs at V=0 cps	
		Flutter Speed	Freq.	Type	Store	C.G. % Chord	Store	Flex No.	Pylon Loc.	Store	Flex No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
	kts	kts	cps															
35	828	828	7.93	A.S.	Launcher	- 54.0				BLU-27/B(F)	1	N	MK-84	1	-	-	5.41	7.37
34	773	-	-	-		- 27.0											5.47	7.43
332	856	736	7.16	A.S.	Launcher	- 81.0				BLU-27/B(F)	1	N	MK-84	5	-	-	5.41	7.27
333	659	659	7.08	A.S.		- 63.0											5.45	7.33
330	577	571	7.08	A.S.		- 54.0											5.36	7.08
331	523	523	7.16	A.S.		- 27.0											5.44	7.33
334	523	523	7.11	A.S.		- 18.0											5.41	7.03
335	491	491	7.11	A.S.		+ 0.06											5.45	7.23
*410	581	581	7.11	A.S.	Launcher	- 54.0				BLU-27/B(F)	1	N	MK-84	5			5.44	7.37
*409	499	491	7.43	A.S.		- 18.0											5.39	7.32
365	853	-	-	-	Launcher	- 81.0				BLU-27/B(F)	1	N	MK-84	Rigid	-	-	5.36	7.23
364	853	-	-	-		- 54.0											5.36	7.43
363	853	-	-	-		- 27.0											5.41	7.32
357	853	-	-	-	Launcher	- 81.0				BLU-27/B(F)	1	N	MK-84	3	-	-	5.41	7.37
356	853	-	-	-		- 54.0											5.36	7.27
355	853	-	-	-		- 27.0											5.47	7.33
372	747	747	10.4	A.S.	Launcher	- 81.0				MK-82	1	N	MK-84	5	-	-	6.00	11.73
373	849	849	11.0	A.S.		- 45.0											5.97	11.81
374	704	704	12.0	A.S.		- 18.0											6.00	11.87
375	640	640	12.3	A.S.		+ 18.1											5.91	11.56
366	681	681	10.2	A.S.	Launcher	- 81.0				MK-82	1	N	MK-84	Rigid	-	-	6.00	12.00
367	553	553	10.3	A.S.		- 45.0											5.91	11.96
368	581	581	10.4	A.S.		- 18.0											6.00	12.00
369	637	637	10.4	A.S.		+ 18.1											5.91	11.81
352	701	701	10.5	A.S.	Launcher	- 81.0				MK-82	1	N	MK-84	3	-	-	5.97	11.43
351	804	804	10.7	A.S.		- 45.0											6.00	12.00
354	863	863	10.7	A.S.		- 27.0											5.97	11.95
350	680	680	12.2	A.S.		- 18.0											5.97	11.96
353	629	629	12.1	A.S.		+ 18.1											6.00	12.00

*Repeat runs with fuselage ballast removed.

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

LAUNCHER + INBOARD STORE + ℄ MK-84 (cont'd)

Run No.	Max. Speed Tested kts	Flutter Characteristics: Flutter Speed kts	Flutter Characteristics: Freq. cps	Flutter Characteristics: Type	Wing Tip: Store	Wing Tip: C.G. % Chord	W.S. 123: Store	W.S. 123: Flex No.	W.S. 123: Pylon Loc.	W.S. 93.5: Store	W.S. 93.5: Flex No.	W.S. 93.5: Pylon Loc.	Fuselage ℄: Store	Fuselage ℄: Flex No.	Fuselage ℄: Store Fuel Content % Full		Symm Freqs at V=0 cps: Bend.	Symm Freqs at V=0 cps: Tors.
454	864	864	9.71	A.S.	Launcher	- 81.0				BLU-32/B(F)	1	N	MK-84	5			5.77	9.29
455	853					- 44.8											5.87	9.29
456	853					- 18.0											5.87	8.89
457	853				Launcher	- 54.0				CBU-24B/B	1	N	MK-84	5			5.52	8.67
458					Launcher	- 54.0				200 LB/22.5 $\frac{\text{Slug}}{\text{ft}^2}$	1	N	MK-84	5			6.67	14.67
411	681	681	7.00	A.S.	1	- 54.0				BLU-27/B(F)	1	N	MK-84	5	-	-	5.15	7.33
412	544	533	7.11	A.S.	1	- 18.0											5.09	7.32
414	595	587	6.93	A.S.	2	- 54.0	—			BLU-27/B(F)	1	N	MK-84	5			5.17	7.33
413	485	485	7.11	A.S.	2	- 18.0											5.09	7.23
415	597	597	6.93	A.S.	3	- 54.0				BLU-27/B(F)	1	N	MK-84	5			4.95	7.23
416	725	725	7.11	A.S.	4	- 54.0				BLU-27/B(F)	1	N	MK-84	5			5.00	7.33
417	560	560	7.11	A.S.	4	- 18.0											4.80	7.33
429	853				5	-127.0				BLU-27/B(F)	1	N	MK-84	5			4.89	7.24
420	827				5	-109.0											4.85	7.12
419	827				5	- 91.0											4.95	7.33
418	811				5	- 73.0											4.95	7.27
427	688	688	6.93	A.S.	5	- 55.0											5.07	7.33
428	581	581	7.03	A.S.	5	- 36.9											5.04	7.33
LAUNCHER + INBOARD STORE + ℄ BLU-27/B(F)																		
391	853				Launcher	- 81.0				BLU-27/B(F)	1	N	BLU-27/B(F)	5			5.47	7.33
392	853					- 18.0											5.41	7.41
395	880				Launcher	- 81.0				MK-82	1	N	BLU-27/B(F)	5			5.97	11.95
394	880					- 18.0											5.91	11.56

1 Launcher Wt = 81.2 lbs, c.g. L.S. 48.8, Icg=26,289 lb in^2
2 Launcher Wt = 81.2 lbs, c.g. L.S. 48.8, Icg=55,089 lb in^2
3 Launcher Wt = 97.2 lbs, c.g. L.S. 48.8, Icg=69,489 lb in^2
4 Launcher Wt = 97.2 lbs, c.g. L.S. 48.8, Icg=26,289 lb in^2
5 Launcher Wt = 97.2 lbs, c.g. L.S. 33.98, Icg=48,156 lb in^2

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

LAUNCHER + OUTBOARD STORE

Run No.	Max. Speed Tested kts	Flutter Characteristics: Flutter Speed kts	Flutter Characteristics: Freq. cps	Flutter Characteristics: Type	Wing Tip: Store	Wing Tip: C.G. % Chord	W. S. 123: Store	W. S. 123: Flex No.	W. S. 123: Pylon Loc.	W. S. 93.5: Store	W. S. 93.5: Flex No.	W. S. 93.5: Pylon Loc.	Fuselage ℄: Store	Fuselage ℄: Flex No.	Fuselage ℄: Store Fuel Content % Full	Airplane Attitude	Symm Freqs at V-0 cps: Bend.	Symm Freqs at V-0 cps: Tors.
55	827				Launcher	-81.0	BLU-27/B(F)	1	N								3.36	4.63
52	811					-63.0											3.36	4.52
53	816					-27.0											3.45	4.59
54	800					+18.1											3.40	4.52
70	853				Launcher	-81.0	MK-82	1	N								4.15	6.40
67	853					-45.0											4.09	6.51
68	853					-27.0											4.13	6.40
69	853					+18.1											4.19	6.40
132	853				Launcher	-81.0	CBU-24B/B	1	N								3.47	5.33
133	880					-63.0											3.48	5.31
134	880					-27.0											3.47	5.33
135	880					+0.06											3.49	5.01
136	880					+18.1											3.49	5.27
141	853				Launcher	-81.0	BLU-32/B(F)	1	N								3.89	5.33
140	853					-63.0											3.87	5.49
139	853					-27.0											3.89	5.27
138	853					+0.06											3.92	5.36
137	853					+18.1											3.95	5.43
142	853				Launcher	-81.0	BLU-32/B(U)	1	N								3.88	5.60
143	853					-27.0											3.95	5.57
144	853					+18.1											3.93	5.48
168	827				Launcher	-81.0	BLU-27/B(U)	1	N								3.41	4.68
167	827					-27.0											3.41	4.67
166	853					+18.1											3.36	4.56
180	853				Launcher	-81.0	MK-82R	1	N								4.11	6.51
179	853					-54.0											4.12	6.48
177	853					-18.0											4.09	6.12
178	853					+18.1											4.17	6.24
181	853				Launcher	-81.0	Empty LAU-3/A	1	N								5.77	11.68
182	853					-54.0											5.87	11.73
183	853					-27.0											5.87	12.3
186	885					- 9.0											5.84	-

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS PHASE I

LAUNCHER + OUTBOARD STORE

Run No.	Max. Speed Tested kts	Flutter Characteristics: Flutter Speed kts	Freq. cps	Type	Wing Tip: Store	C.G. % Chord	W.S. 123: Store	Flex No.	Pylon Loc.	W. S. 93.5: Store	Flex No.	Pylon Loc.	Fuselage ℄: Store	Flex No.	Store Fuel Content % Full	Airplane Attitude	Symm Freqs at V=0 cps: Bend.	Tors.
185	811	811	10.7	A.S.	Launcher	+0.06	Empty LAU-3/A	1	N								5.87	11.73
187	757	757	10.7	A.S.		+9.1											5.84	11.56
184	731	731	10.7	A.S.		+18.1											5.87	-
209	853				Launcher	-81.0	400 lb/22.5 slug ft^2	1	N								4.37	7.12
208	853					-54.0											4.41	7.08
207	853					-27.0											4.41	6.97
206	853					+0.06											4.44	6.93
205	853					+18.1											4.44	6.89
200	880				Launcher	-81.0	Pylon	1	N								6.23	13.33
201	880					-54.0											6.27	14.09
202	880					-27.0											6.19	14.44
203	880					+0.06											6.19	14.44
204	840	840	12.24	A.S.		+18.1											6.19	14.44
LAUNCHER + OUTBOARD STORE + INBOARD STORE																		
42	853				Launcher	-54.0	Pylon	1	N	BLU-27/B(F)	1	N					5.00	7.27
41	853					-27.0											5.07	7.24
72	853				Launcher	-54.0	MK-82	1	N	Pylon	1	N					4.09	6.45
71	853																4.19	6.59
481	720				Launcher	-81.0	MK-82	1	N	MK-82	1	N					4.00	6.55
480	720					-36.0											3.97	6.52
222	880				Launcher	-81.0	Pylon	1	N	Pylon	1	N					6.09	13.33
223	880					-54.0											6.12	13.87
224	880					-27.0											6.23	14.67
225	864	859	12.44	A.S.		+18.0											6.13	14.53
51	595	595	7.47	A.S.	Launcher	-27.0	Pylon	1	N	BLU-27/B(F)	1	N	275 G. Tank	1	Full	Level	5.04	7.27

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + INBOARD STORE

Run No.	Max. Speed Tested kts	Flutter Characteristics			Wing Tip		W. S. 123			W. S. 93.5			Fuselage ℄			Airplane Attitude	Symm Freqs at V = 0 cps	
		Flutter Speed kts	Freq. cps	Type	Store	C.G. % Chord	Store	Flex. No.	Pylon Loc.	Store	Flex No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
37	695	695	7.43	SYM	AIM-9J	-75.5				BLU-27/B(F)	1	N					4.00	6.12
38	780	780	7.48	SYM		-57.5											4.03	6.23
18	739					-30.4											4.09	6.27
17	539	539	6.55	A.S.		-21.4											4.09	6.23
*15	528	528	6.66	A.S.		-3.4											4.12	6.33
16	597	597	6.75	A.S.		+14.6											4.07	6.35
19	635	635	5.37	SYM		+23.6											4.00	6.35
82	853				AIM-9J	-75.5				MK482	1	N					4.11	6.55
81	853					-57.4											4.19	6.55
76	853					-21.4											4.29	6.77
78	853					-12.4											4.24	6.71
77	529	529	7.11	A.S.		-3.4											4.23	6.80
79	509	509	7.20	A.S.		+5.6											4.27	6.81
80	587	587	7.33	A.S.		+23.6											4.21	6.85
111	762	762	8.29	SYM	AIM-9J	-75.5				BLU-32/B(F)	1	N					4.07	--
112	819	819	8.24	SYM		-57.5											4.17	6.52
106	880					-21.4											4.24	6.59
107	880					-12.4											4.23	6.67
108	533	533	6.97	A.S.		-3.4											4.23	6.67
110	533	533	7.07	A.S.		+5.6											4.23	6.67
109	616	616	5.56	SYM		+23.6											4.19	6.67
119	867	867	7.93	SYM	AIM-9J	-75.5				CBU-24B/B	1	N					4.00	--
118	885					-57.5											4.00	--
117	853					-39.4											4.15	6.67
113	853					-21.4											4.15	6.67
115	405	405	6.85	A.S.		-12.4											4.15	6.67
114	467	467	7.00	A.S.		+5.6											4.13	6.67
116	568	568	7.11	A.S.		+23.6											4.12	6.67
235	691	691	7.37	SYM	AIM-9J	-75.5				BLU-27/B(U)	1	N					3.93	6.04
236	787	787	7.32	SYM		-57.5											4.00	6.08
237	880					-39.4											4.03	6.23
239	880					-30.4											4.07	6.19

*Repeated in Run 90 to check effect of additional stability ballast; flutter speed = 528, flutter freq = 6.66 Hz A.S.
Repeat of Run 5 to check effect of removing aft drag cables. Run 5; flutter speed = 626 flutter freq = 5.36 Hz Symm.

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + INBOARD STORE

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W. S. 123			W. S. 93.5			Fuselage ℄				Symm Freqs at V = 0 cps	
		Flutter Speed	Freq.	Type	Store	C.G. % Chord	Store	Flex. No.	Pylon Loc.	Store	Flex No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
	kts	kts	cps															
238	491	491	6.59	A.S.	AIM-9J	-21.4				BLU-27/B(U)	1	N					4.09	6.23
240	509	509	6.75	A.S.		- 3.4											4.09	6.31
241	619	619	5.40	SYM		+23.6											4.07	6.40
93	896	896	9.33	SYM	AIM-9J	-75.5				Pylon	1	N					4.23	6.89
96	880					-48.5											4.44	6.85
92	880					-21.4											4.53	6.81
94	880					-3.4											4.44	6.93
95	701	701	5.92	SYM		+5.6											4.44	6.93
91	581	581	6.00	SYM		+23.6											4.37	7.11

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + INBOARD STORE + ℄ STORE

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W.S. 123			W. S. 93.5			Fuselage ℄			Airplane Attitude	Symm Freqs at V=0 cps	
	kts	Flutter Speed kts	Freq. cps	Type	Store	C.G. % Chord	Store	Fuel No.	Pylon Loc.	Store	Fuel No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
*12	699	699	7.56	Sym	AIM-9J	-75.5				BLU-27/B(F)	1	N	MK-84	1			3.93	6.23
11	736	736	7.47	Sym		-66.5											4.00	6.23
14	789	789	7.47	Sym		-57.5											4.00	6.20
8	784					-39.4											3.93	6.19
10	784					-30.4											4.10	6.33
9	331	331	6.40	A.S.		-21.4											4.15	6.33
7	411	411	6.52	A.S		- 3.4											4.03	6.27
6	533	533	6.59	A.S.		+23.6											4.00	6.33
28	699	699	7.47	Sym	AIM-9J	-75.5				BLU-27/B(F)	1	N	275 G. Tank	1	Full	Level	4.00	6.13
29	789	789	7.37	Sym		-57.5											4.00	6.16
27	805					-30.4											4.07	6.19
25	352	352	6.36	A.S.		-21.4											4.09	6.23
26	416	416	6.35	A.S.		- 3.4											4.12	6.36
24	504	504	6.44	A.S.		+23.6											4.08	6.36
253	691	691	7.40	Sym	AIM-9J	-75.5				BLU-27/B(F)	1	N	275 G. Tank	5	Full	Level	3.93	6.04
254	787	787	7.37	Sym		-57.5											4.00	6.12
252	827					-21.4											4.11	6.23
255	544	480	5.97	A.S.		-12.4											4.11	6.27
251	460	437	6.09	A.S.		- 3.4											4.07	6.23
250	459	459	6.05	A.S.		+23.6											4.05	6.31
286	853				AIM-9J	-30.4				BLU-27/B(F)	1	N	275G. Tank	Rigid	Full	Level	4.11	6.23
285	421	421	6.48	A.S.		-21.4											4.03	6.19
281	459	459	6.60	A.S.		- 3.4											4.11	6.23
284	531	531	6.67	A.S.		+14.6											4.00	6.27
283	576	571	6.67	A.S.		+23.6											4.03	6.35
312	880				AIM-9J	-30.4				BLU-27/B(F)	1	N	275 G. Tank	2	Full	Level	4.07	6.19
311	360	360	6.31	A.S.		-21.4											4.07	6.19
313	427	427	6.41	A.S.		- 3.4											4.07	6.27
314	539	539	6.55	A.S.		+23.6											4.03	6.27
327	880				AIM-9J	-21.4				BLU-27/B(F)	1	N	275 G. Tank	3	Full	Level	4.13	6.23
326	605	533	6.00	A.S.		-12.4											4.12	6.23
325	464	464	6.00	A.S.		+23.6											4.00	6.31

*Repeated in Run 36 to check the effect of pitch dampers; flutter speed = 693 flutter freq = 7.43 Hz symm.

F-5E FLUTTER ·MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + INBOARD STORE + CENTERLINE STORE (continued)

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W.S. 123			W.S. 93.5			Fuselage ℄			Airplane Attitude	Symm Freqs at V = 0 cps	
		Flutter Speed	Freq.	Type	Store	C.G. % Chord	Store	Fuel No.	Pylon Loc.	Store	Fuel No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
	kts	kts	cps															
23	773				AIM-9J	-30.4				BLU-27/B(F)	1	N	275 G. Tank	1	50%	Level	4.07	6.19
22	523	523	6.67	A.S.		-21.4											4.12	6.33
*21	504	504	6.63	A.S.		-3.4											4.12	6.33
386	853				AIM-9J	-30.4				BLU-27/B(F)	1	N	275 G. Tank	5	50%	Level	4.05	6.16
385	541	541	6.67	A.S.		-21.4											4.09	6.23
387	484	484	6.64	A.S.		-12.4											4.12	6.23
384	616	616	6.67	A.S.		+23.6											4.00	6.27
404	853				AIM-9J	-30.4				BLU-27/B(F)	1	N	275 G. Tank	5	75%	Level	4.11	6.23
403	507	485	6.44	A.S.		-21.4											4.11	6.23
405	464	464	6.48	A.S.		-12.4											4.07	6.12
340	696	696	7.37	SYM	AIM-9J	-75.5				BLU-27/B(F)	1	N	MK-84	5			3.93	6.01
341	789	789	7.32	SYM		-57.5											4.00	6.13
338	853					-30.4											4.09	6.19
337	267	267	6.23	A.S.		-21.4											4.07	6.19
336	315	315	6.31	A.S.		-12.4											4.15	6.23
339	469	469	6.39	A.S.		+23.6											4.03	6.23
362	853				AIM-9J	-30.4				BLU-27/B(F)	1	N	MK-84	Rigid			4.11	6.23
361	419	419	6.09	A.S.		-21.4											4.07	6.12
359	853				AIM-9J	-30.4				BLU-27/B(F)	1	N	MK-84	3			4.07	6.20
358	307	307	6.23	A.S.		-21.4											4.12	6.23
360	451	451	6.27	A.S.		+23.6											4.07	6.31
264	885	885	8.52	SYM	AIM-9J	-75.5				MK-82	1	N	275 G. Tank	5	Full	Level	4.08	6.49
262	853					-3.4											4.23	6.71
263	712	712	6.40	A.S.		+5.6											4.23	6.80
261	553	553	6.23	A.S.		+23.6											4.23	6.85
298	880				AIM-9J	-12.4				MK-82	1	N	275 G. Tank	Rigid	Full	Level	4.23	6.67
297	347	347	6.89	A.S.		-3.4											4.24	6.80
300	397	397	6.93	A.S.		+5.6											4.23	6.85
299	507	507	7.00	A.S.		+23.6											4.19	6.85

*Repeat of Run 20 to check the effect of pitch dampers. Run 20; flutter speed = 504 flutter freq = 6.67 Hz A.S.

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + INBOARD STORE + ℄ STORE (continued)

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W.S. 123			W.S. 93.5			Fuselage ℄			Airplane Attitude	Symm Freqs at V = 0 cps	
		Flutter Speed	Freq.	Type	Store	C.G. % Chord	Store	Fuel No.	Pylon Loc.	Store	Fuel No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
	kts	kts	cps															
302	880				AIM-9J	-12.4				MK-82	1	N	275 G. Tank	Rigid	Full	Level	4.27	6.67
301	344	344	6.93	A.S.		-3.4											4.23	6.71
317	853				AIM-9J	-12.4				MK-82	1	N	275 G. Tank	2	Full	Level	4.23	6.71
316	328	328	6.79	A.S.		-3.4											4.27	6.77
315	483	484	6.85	A.S.		+23.6											4.16	6.80
322	880	837	6.12	A.S.	AIM-9J	-3.4				MK-82	1	N	275 G. Tank	3	Full	Level	4.27	6.79
323	672	672	6.16	A.S.		+5.6											4.19	6.71
324	549	549	6.23	A.S.		+23.6											4.16	6.80
346	872	872	8.52	SYM	AIM-9J	-75.5				MK-82	1	N	MK-84	5			4.03	6.51
345	853					-12.4											4.27	6.79
344	403	403	6.52	A.S.		-3.4											4.18	6.84
343	400	400	6.51	A.S.		+5.6											4.27	6.80
342	451	443	6.55	A.S.		+23.6											4.16	6.75
349	853				AIM-9J	-12.4				MK-82	1	N	MK-84	3			4.27	6.73
348	472	472	6.31	A.S.		-3.4											4.27	6.77
347	453	453	6.41	A.S.		+23.6											4.19	6.81
371	853				AIM-9J	-12.4				MK-82	1	N	MK-84	Rigid			4.23	6.67
370	355	355	6.89	A.S.		-3.4											4.27	6.76
402	853				AIM-9J	-12.4				MK-82	1	N	275 G. Tank	5	75%	Level	4.27	6.67
401	512	469	6.85	A.S.		-3.4											4.24	6.67
381	853				AIM-9J	-12.4				MK-82	1	N	275 G. Tank	5	50%	Level	4.23	6.67
380	499	499	6.67	A.S.		-3.4											4.27	6.77
382	477	477	6.93	A.S.		+5.6											4.27	6.80
383	568	568	7.11	A.S.		+23.6											4.19	6.85
453	760	760	8.27	SYM	AIM-9J	-75.5				BLU-32/B(F)	1	N	MK-84	5			4.13	6.40
452	825	825	8.24	SYM		-57.5											4.15	6.41
451	853					-21.4											4.23	6.56
450	381	381	6.40	A.S.		-12.4											4.20	6.59
449	360	360	6.40	A.S.		-3.4											4.23	6.67
448	448	448	6.55	A.S.		+23.6											4.15	6.67

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + INBOARD STORE + ℄ STORE (contd)

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W.S. 123			W. S. 93.5			Fuselage ℄			Airplane Attitude	Symm Freqs at V = 0 cps	
	kts	Flutter Speed kts	Freq. cps	Type	Store	C.G. % Chord	Store	Fuel No.	Pylon Loc.	Store	Fuel No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
265	773	773	8.12	SYM	AIM-9J	-75.5				BLU-32/B(F)	1	N	275 G. Tank	5	Full	Level	4.00	6.35
266	837	837	8.20	SYM		-57.4											4.13	6.35
270	853					12.4											4.20	6.67
267	667	667	6.16	A.S.		-3.4											4.23	6.67
268	547	547	6.23	A.S.		+5.6											4.16	6.63
269	533	491	6.23	A.S.		+23.6											4.15	6.67
279	871	871	8.00	SYM	AIM-9J	-75.5				CBU-24B/B	1	N	275 G. Tank	5	Full	Level	3.93	6.35
280	784					-3.4											4.11	6.57
435	716	716	7.48	SYM	AIM-9B	-71.8	—			BLU-27/B(F)	1	N	MK-84	5			4.00	6.40
434	892	892	7.56	SYM		-53.8											4.07	6.45
433	853					-35.8											4.09	6.51
432	533	533	6.27	A.S.		-26.8											4.15	6.60
431	416	411	6.40	A.S.		-17.8											4.09	6.59
430	416	416	6.40	A.S.		-8.8											4.15	6.67
436	512	507	6.52	A.S.		+27.3											4.03	6.59
440	860	859	8.67	SYM	AIM-9B	-71.8				MK-82	1	N	MK-84	5			4.13	7.03
439	856					-8.8											4.29	7.47
438	621	621	6.67	A.S.		+0.3											4.27	7.32
441	563	563	6.79	A.S.		+9.3											4.27	7.47
437	541	541	6.75	A.S.		+27.3											4.24	7.47
445	709	704	8.25	SYM	AIM-9B	-71.8				BLU-32/B(F)	1	N	MK-84	5			4.12	6.93
446	784	784	8.25	SYM		-53.8											4.17	6.89
444	853					-17.8											4.27	7.11
443	595	595	6.55	A.S.		-8.8											4.24	7.20
442	528	528	6.67	A.S.		+0.3											4.21	7.12
447	513	513	6.67	A.S.		+27.3											4.19	7.24
425	653	653	7.33	SYM	AIM-9J (5)	-87.3				BLU-27/B(F)	1	N	MK-84	5			3.77	5.77
421	717	717	7.25	SYM	(5)	-69.3											3.67	5.81
426	817	817	7.27	SYM	(5)	-51.2											3.81	5.84
422	827				(5)	-33.2											3.87	5.87
424	800				(5)	-24.2											3.87	5.91
423	315	315	6.04	A.S.	(5)	-15.2											3.85	5.95

(5) Launcher Wt = 97.2 lbs, c.g. L.S. 33.98, Icg = 48,156 lb in^2

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + OUTBOARD STORE

Run No.	Max. Speed Tested kts	Flutter Characteristics: Flutter Speed kts	Flutter Characteristics: Freq. cps	Flutter Characteristics: Type	Wing Tip: Store	Wing Tip: C.G. % Chord	W. S. 123: Store	W. S. 123: Flex No.	W. S. 123: Pylon Loc.	W. S. 93.5: Store	W. S. 93.5: Flex No.	W. S. 93.5: Pylon Loc.	Fuselage ℄: Store	Fuselage ℄: Flex No.	Fuselage ℄: Store Fuel Content % Full	Airplane Attitude	Symm Freqs at V=0 cps: Bend.	Symm Freqs at V=0 cps: Tors.
56	853				AIM-9J	-75.5	BLU-27/B(F)	1	N								3.03	4.23
57	853					-48.5											3.08	4.16
58	853					-21.4											3.12	4.08
59	853					+23.6											3.17	3.91
64	827				AIM-9J	-75.5	MK-82	1	N								3.43	5.33
62	827					-48.4											3.44	5.41
66	856	856	6.52	A.S.		-39.4											3.49	5.36
63	811	811	6.51	A.S.		-30.4											3.52	5.39
61	821	821	6.55	A.S.		-21.4											3.52	5.39
65	853					- 3.4											3.52	5.21
60	827					+23.6											3.56	5.00
150	853	853	5.77	A.S.	AIM-9J	-75.5	BLU-32/B(U)	1	N								3.33	4.95
149	853					-48.5											3.27	4.67
148	853					-30.4											3.40	4.80
147	853					-21.4											3.43	4.67
146	869					- 3.4											3.43	4.64
145	864					+23.6											3.47	4.51
151	853				AIM-9J	-75.5	BLU-32/B(F)	1	N								3.33	4.85
152	853					-21.4											3.42	4.76
153	853					+23.6											3.44	4.40
158	853				AIM-9J	-75.5	MK-82R	1	N								3.41	5.59
157	853					-57.5											3.47	5.53
161	880					-54.0											3.40	5.29
156	816	816	6.48	A.S.		-39.4											3.47	5.40
160	805	805	6.52	A.S.		-30.4											3.51	5.33
155	832	832	6.52	A.S.		-21.4											3.52	5.20
159	853					- 3.4											3.56	5.17
154	853					+23.6											3.56	5.00
163	800				AIM-9J	-75.5	BLU-27/B(U)	1	N								3.05	4.23
162	827					-54.0											3.11	4.24
164	827					-21.4											3.13	4.09
165	827					+23.6											3.20	4.00

F-5B FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + OUTBOARD STORE

Run No.	Max. Speed Tested kts	Flutter Characteristics: Flutter kts	Flutter Characteristics: Freq. cps	Flutter Characteristics: Type	Wing Tip: Store	Wing Tip: C.G. % Chord	W. S. 123: Store	W. S. 123: Flex No.	W. S. 123: Pylon Loc.	W. S. 93.5: Store	W. S. 93.5: Flex No.	W. S. 93.5: Pylon Loc.	Fuselage ℄: Store	Fuselage ℄: Flex No.	Fuselage ℄: Store Fuel Content % Full	Airplane Attitude	Symm Freqs at V = 0 cps: Bend.	Symm Freqs at V = 0 cps: Tors.
169	741	741	5.49	A.S.	AIM-9J	-75.5	CBU-24B/B	1	N								3.07	4.80
170	835	835	5.57	A.S.		-57.5											3.08	4.73
171	853					-39.4											3.09	4.60
172	781	781	7.88	SYM		-21.4											3.15	4.59
176	800	800	8.00	SYM		-12.4											3.13	4.53
173	763	763	8.00	SYM		-3.4											--	--
174	821	821	8.17	SYM		+14.6											3.15	4.37
175	853	853	8.27	SYM		+23.6											3.20	4.39
191	885				AIM-9J	-75.5	Empty LAU-3/A	1	N								3.95	6.57
190	853					-48.5											4.08	6.67
189	853					-3.4											4.15	6.57
192	888	888	5.52	SYM		+5.6											4.15	6.57
188	741	741	5.33	SYM		+14.6											4.12	6.67
193	648	648	5.47	SYM		+23.6											4.11	6.59
210	853				AIM-9J	-75.5	400 lb/22.5 sl ft^2	1	N								3.51	5.77
211	853					-48.5											3.59	5.75
214	880					-39.4											3.59	5.72
213	880					-30.4											3.63	5.65
212	880					-21.4											3.64	5.59
215	853					+5.6											3.67	5.41
216	853					+23.6											3.67	5.28
199	891				AIM-9J	-75.5	Pylon	1	N								4.08	6.67
198	853					-48.5											4.19	6.67
197	880					-3.4											4.27	6.81
196	779	779	5.69	SYM		+5.6											4.27	6.81
195	672	672	5.77	SYM		+14.6											4.27	6.89
194	629	629	5.73	SYM		+23.6											4.20	6.89

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + OUTBOARD STORE + INBOARD STORE

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W. S. 123			W. S. 93.5			Fuselage ℄				Symm Freqs at V=0 cps	
		Flutter Speed	Freq.	Type	Store	C.G. % Chord	Store	Flex No.	Pylon Loc.	Store	Flex No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
	kts	kts	cps															
45	832	832	7.40	Sym	AIM-9J	-57.5	Pylon	1	N	BLU-27/B(F)	1	N					3.91	6.17
44	800					-30.4											3.92	6.16
43	555	555	6.67	A.S.		-21.4											3.95	6.23
73	853				AIM-9J	-48.4	MK-82	1	N	Pylon	1	N					3.51	5.60
74	805	805	6.59	A.S.		-21.4											3.56	5.44
75	736				AIM-9J	-21.4	BLU-27/B(F)	1	N	BLU-27/B(F)	1	N					2.96	3.93
221	896				AIM-9J	-75.5	Pylon	1	N	Pylon	1	N					4.08	6.67
220	880					-48.5											4.19	6.76
219	880					-21.4											4.24	6.79
218	827	827	5.65	Sym		+ 5.6											4.23	6.85
217	647	647	5.68	Sym		+23.6											4.20	6.89
475	720				AIM-9J	-39.4	MK-82	1	N	MK-82	1	N					3.42	5.41
479	720	720	6.31	A.S.		-30.4											3.47	5.37
476	697	693	6.27	A.S.		-21.4											3.47	5.41
478	713	713	6.35	A.S.		-12.4											3.44	5.37
477	728	728	6.40	A.S.		- 3.4											3.47	5.33
474	693				AIM-9E	-71.8	MK-82	1	N	MK-82	1	N					3.41	5.77
482	720	720	6.40	A.S.		-44.8											3.47	5.77
473	640	640	6.27	A.S.		-35.8											3.51	5.67
483	648	648	6.35	A.S.		-26.8											3.44	5.48
472	668	667	9.60	A.S.		+ 0.3											3.51	5.43

F-5E FLUTTER MODEL, WIND TUNNEL TEST RESULTS, PHASE I

MISSILE + OUTBOARD STORE + INBOARD STORE + ℄ STORE

Run No.	Max. Speed Tested	Flutter Characteristics			Wing Tip		W. S. 123			W. S. 93.5			Fuselage ℄				Symm Freqs at V=0 cps	
		Flutter Speed	Freq	Type	Store	C.G. % Chord	Store	Flex No.	Pylon Loc.	Store	Flex No.	Pylon Loc.	Store	Flex No.	Store Fuel Content % Full		Bend.	Tors.
	kts	kts	cps															
47	741	741	7.39	Sym	AIM-9J	-75.5	Pylon	1	N	BLU-27/B(F)	1	N	MK-84	1			3.84	6.05
46	837	837	7.33	Sym		-57.5											3.85	6.04
49	789					-30.4											3.93	6.23
48	371	371	6.35	A.S.		-21.4											3.91	6.19
50	437	437	6.48	A.S.		- 3.4											3.91	6.19
485	720				AIM-9B	-44.8	MK-82	1	N	MK-82	1	N	MK-84	5			3.47	5.72
484	720					-26.8											3.43	5.53

AD NUMBER	DATE	DTIC ACCESSION NOTICE

1. REPORT IDENTIFYING INFORMATION	**REQUESTER:**
A. ORIGINATING AGENCY Northrop Corporation	*1. Put your mailing address on reverse of form.*
B. REPORT TITLE AND/OR NUMBER F-5E Flutter Model Test Report.	*2. Complete items 1 and 2.* *3. Attach form to reports mailed to DTIC.*
C. MONITOR REPORT NUMBER NOR 71-162	*4. Use unclassified information only.*
D. PREPARED UNDER CONTRACT NUMBER	**DTIC:**
2. DISTRIBUTION STATEMENT A	*1. Assign AD Number.* *2. Return to requester.* ASIAC 334

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